THE

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MR. SIEMENS'S PRESIDENTIAL ADDRESS.

IN many respects the Presidential Address of Mr. Siemens is decidedly disappointing. It may be that one had associated with Mr. Siemens a high degree of excellence, and as great expectations never are fulfilled, so may one account for the comparative failure of his address. Not that the paper is barren of suggestions, for the new President of the Institution of Electrical Engineers takes a deep and active interest in the problems of transmission of electrical energy, has a keen regard for the advancement of electric traction, and is in the very midst of central station practice. His recent visit to America gave him an opportunity to contrast the solidity of English with American work; naturally we come off first in such a comparison; but after all it is of very little importance, and perhaps if English electrical manufacturers had had to face the emergencies of their American cousins, they might have been constrained to do hurried work at the expense of good design. Mr. Siemens, to some extent, adopts the historical method, and, dwelling on the first Electric Light Act, falls foul of the obnoxious clause of the Act of 1882, which gave a local authority the right to buy out an electric lighting company after the lapse of 21 years, upon paying the market value of the plant. This, no doubt, was the act of a wicked democrat, but fortunately this unjust arrangement has been undone and a more equitable adjustment substituted. We cannot share the President's surprise that few local authorities availed themselves of the powers given under the old Act. It is to be doubted whether the most favourable electric lighting legislation before 1888 would have justified municipal authorities taking up the supply of electricity. The knowledge of town lighting gained during the past few years has been enormous, and the fact that not one of the old supply systems has been successful, seems to us to have justified the tardy action of corporations. As Mr. Siemens points out, we compare badly with America as regards the facilities of establishing supplies; but is this altogether to be regretted? Many people object, or think they do, to grandmotherly legislation, but it is appalling to imagine the might-have-beens, had protection not been vouchsafed by a parental Government. It is this grandmotherly legislation which has saved us from many of the horrors of American life. Which of the English railway companies would have the slightest objection to run their trains down the principal streets if they were not absolutely prevented by stringent laws? Joint-stock enterprise, not possessing a soul, does not hesitate to ride rough-shod over the public, and wherever opportunity presents itself the iron hoof is felt. One very good reason given by Mr. Siemens for the rapid growth of electric lighting in America, compared with England, is "that an important factor in retarding the spread of the applications of electricity in this country is the

otherwise very laudable desire of the electrical engineers to show in every new undertaking a distinct advance on its predecessor. In this way, the details of construction are undergoing constant changes, in strong contrast to the United States, where the leading manufacturers have their standard size of plant and accessories. These are manufactured wholesale by specially-designed machinery, and can, therefore, be supplied much more cheaply than apparatus specially constructed for each case."

This American system, as Mr. Siemens rightly suggests, is not instrumental in conducing to the most economical results, nor would American work, generally speaking, compare with English. At the same time, it is quite an open question whether English consulting engineers have not shown too ready a disposition to make experiments in town lighting at the expense of municipal authorities. Experience had to be gained, but we have our doubts whether, in many instances, the results justified the lavish expenditure. It must not be understood that we put this forward as an argument against municipal authorities undertaking local lighting; for a careful scheme, honestly carried out, places a local authority in an impregnable position.

The evolution of mechanical design in dynamos was ably set forth by Mr. Siemens. In the opinion of the pioneers, the desiderata of a dynamo were small size and low weight; the necessity of having the moving parts durable, and of not always working the machine up to its maximum power, being totally ignored. It was not until the mechanical man took up dynamo building that we really obtained a machine which was fitted for the exigencies of electric supply. This, of course, brought in its train improvements in the steam engines, and then the combined plant had to undergo most severe tests, which resulted in the efficiency reaching a high standard. Electrical engineers may well be proud of what has been accomplished in the improvement of the dynamo, but have we not almost reached the point when it might be neglected with advantage, henceforth concentrating our attention on the remaining weak parts of a supply system.

Naturally the transmission of power occupies a prominent position in Mr. Siemens's address. He considers that it would be rash to predict that a speed of 200 miles per hour could not be attained, but he refers to points, which we have so often urged in these columns, that trebling the speed of a train would necessitate a radical alteration in the laying of permanent way, and specially built carriages involving, of course, an enormous expense. No doubt the great outlay would be justified if trains were frequent enough, but it is quite a moot point whether a very frequent service would be required between such places as London, Liverpool, Manchester, Glasgow; for, after all, a service at short intervals would not increase the number of passengers, and the few trains which are now run are usually more than sufficient to accommodate travellers. Frequent trains to the suburban districts of a large town are an absolute necessity, but extra high speeds would be unnecessary, and, as a matter of fact, would be difficult to attain on a short length of line.

Regulations relating to traction, and the value of a collegiate training, are subjects which are dealt with, unfortunately, very shortly. With regard to State interference, Mr. Siemens makes the curious statement that the industries of this country have been developed to the great advantage of the nation, with very little legislative interference. When we consider what radical alterations have been introduced in the employment of women and children in factories and workshops, when we consider the attempts that have been made to improve the sanitary conditions of the workers, we really fail to see the applicability of the remark.

ELECTRICITY AND ARTILLERY PRACTICE: A NEW FIELD FOR ENTERPRISE.

Artillerists are beginning to recognise that electricity may prove to be a most useful adjunct to their offensive and defensive tactics. Already it has been used with great success in range-finding, aiming, and firing; and it seems very likely that its applications will soon be multiplied. At present all big guns, whether on board ship or in a fort, are manipulated by steam or by hydraulic power, and artillerists are not entirely satisfied with the results. For many reasons it is believed that the electric motor is *par excellence* the machine best adapted to the transformation of energy into artillery work, and in foreign countries at least we may look for a speedy interpretation of this belief into practice. It appears that to obtain the full effect the gun must be arranged to load, aim, and fire whilst in motion; and these objects may be attained by the use of electric motors with the greatest facility, and with the additional advantage of being capable of control from any part of the circuit. This latter consideration is important in connection with present tendencies, which are towards entire control from central stations. Again, the angular motions of a moving ship with respect to the gun can be produced and maintained in battle and the gun kept pointed always on the enemy. The same may be said of the elevation and other movements; and it may be contended that such tactical advantages, added to those of economy and simplicity, at least render the electric motor worthy of exhaustive trial.

A more easily understandable application of electricity to the game of war is the use of projectors for sea-coast work. Here the average electrical engineer will feel more confident in making suggestions as well as in carrying out an installation. There are two main functions which can be usefully exercised by projectors in connection with artillery practice on shore, namely: 1. The recognition of distant points or objects. 2. The illumination of extensive zones at short distances. The first requires great concentration, and the second dispersion of light. On Her Majesty's ships the use of electric projectors has become general; but the shore authorities appear to take them up rather tardily.

A writer in the *Memorial de Artillerice* advocates the installation of electric projectors at all important shore positions; and surely if this seems desirable from an Italian point of view, how much more, therefore, is it so from the English standpoint. Projectors for distant illumination should be established on elevated positions; those which are intended to illumine extensive zones at short distance should be as close as possible to the sea level. This separation of the projectors into different groups for different purposes imposes the direction of movements from a point distant from both. In this manner alone can the projectors be made independent of each other, and can be directed

from a central station, although they may be placed in positions difficult of access. Thus the light can be placed in the most advanced positions, and can be manipulated without any exposure, whilst the responsibility for direction lies in a single hand, the persons employed are reduced to a minimum number, and the chances of error are reduced. The most recent proposition is to mount the projector upon a kind of electric car, which runs upon a line of rails; on the car the operator sits and controls the light at will.

There can be no doubt that if a system of projectors were established around our coasts, the defence of the country would be much more easy and certain. It is a matter which appeals to every Englishman, except such as believe in a Little Britain. To all electrical engineers it has an interest beyond that which is caused by their patriotism. It suggests an outlet for commercial enterprise and a field for personal energy which it will be profitable to exploit, and it will be well to keep it in mind.

Electric Light from Town Refuse.

"THE electric light is admittedly the light of the near future, and every town and village in the country has within its reach a store of fuel, in its refuse, which would go a long way towards furnishing the necessary power." Such is the deliberate opinion expressed by Messrs. C. Rawson and C. Smithson, in a recent paper on "The Treatment and Utilisation of Town Refuse," read before the Yorkshire Section of the Society of Chemical Industry. By reference to experimental data they showed that town refuse contains a very considerable quantity of combustible matter, which, by proper treatment, may be rendered available for the production of steam with great facility. This is not a new fact, but it needs insisting upon. They calculate that the refuse of Leeds, say 360 tons per diem, should be capable of evaporating 378 tons of water in 24 hours, or 35,280 lbs. per hour. Taking 20 lbs. of steam per horse-power, Leeds might, on this basis, obtain an amount of steam equivalent to 1,764 H.P. continuously. In like manner the refuse of Bradford, according to the authors, should produce steam equivalent to a continuous horse-power of 948. Not the least interesting part of the paper was that which dealt with the disposal of heterogeneous matters known as "scavengers' perquisites." It must be borne in mind that the paper was compiled from the results of series of experiments by the authors and may have been a little premature, for the criticism which followed it was of a somewhat discouraging order. The authors, it would seem, have never read the recent articles published by Mr. Tomlinson in the ELECTRICAL REVIEW, or they would not have formed the conclusions at which they have now arrived. Thanks, however, are due to Messrs. Rawson and Smithson for their contribution to the discussion of a question which is particularly interesting to electrical engineers, and it is to be hoped that they will renew their investigation.

Elongation in Soft Iron by Magnetism.

WHEN Mons. Alfonse Berget's paper on this subject appeared in the *Comptes Rendus* (November 7th, 1892), the results of his experiments appeared to contradict those of Mr. Shelford Bidwell, which were published in the *Proceedings of the Royal Society* (Vol. xl., pp. 109, 257, 486). This contradiction, however, turns out to be only apparent, for Mr. Sidney J. Lochner, Fellow of Clark University, Worcester, Mass., U.S.A., has recently succeeded in verifying the experimental results of both. An account of the apparatus and methods of observation employed may be consulted in the *Phil. Mag.* for December. These observations furnish the following evidence in regard to the expansion which takes place when soft iron bars are magnetised, viz.: (1) They confirm the general form of Mr. Shelford Bidwell's curves. (2) They indicate that the expansion is a function of the ratio between the diameter and the length, and that the elongation varies directly as, possibly, the square root of this ratio. (3) They further indicate that the expansion varies directly as the permeability. (4) That the amount of current required to produce the maximum expansion, and also the point of no expansion likewise depends upon the ratio between the diameter and length. (5) That there are two maxima: one produced by increasing the current, another by decreasing the current from the point which produces the first maximum. (6) They confirm Prof. Mayer's observations that the first contact gives more expansion than the second and following contacts; whilst even these seem to disagree slightly amongst themselves, the expansion falling off with subsequent contacts.

Electricity in the Metallurgical Laboratory.

A DYNAMO for all-round use in a metallurgical laboratory, should be capable of producing currents of electricity varying considerably in character. To meet this requirement W. Borchers has recently designed a handy form of machine in which the coils are wound round the armatures and magnets in sections, which can be coupled up or otherwise used in various ways. Such a machine has given the following results :—

Volts.	Ampères.
4 to 6	120
10 „ 15	60
25 „ 30	30
50 „ 60	15

This machine is capable of maintaining 20 16-C.P. lamps, or, with the aid of accumulators previously charged by the machine, 15 additional ones. A large variety of laboratory experimental purposes, including illumination, can be effected by this machine. Another interesting arrangement to those engaged in metallurgical work is an electric crucible described in *Le Génie Civil*, which can be used for fusing various refractory substances. A strong current is passed through two suitable carbons, which, in all respects, are similar to the carbons of the arc light. The apparatus contains a directing magnet which regulates the operation of the current. By this device the arc can be brought gradually to bear upon the surface of the matter within the crucible.

Recent Researches on Hysteresis.

SINCE the discovery that the length of an iron bar is changed by magnetisation, the subject has been studied by Mayer, Barrett, Bidwell, and Berget. Bidwell carried the investigation into very strong magnetising fields, and discovered several new facts concerning the changes of length in ferromagnetic substances. Up to the present, however, nothing had been definitely established regarding the manner in which these substances change length during cyclic changes of magnetisation. Recognising the desirability of more knowledge in this direction, Mr. H. Nagaoka, of Rigakushi, recently undertook an investigation, the object of which was to ascertain if there is any hysteresis in the changes of length during magnetic cycles, and at the same time to determine its amount In measuring the successive changes of length of iron and nickel wires subjected to cyclic magnetisations, Mr. Nagaoka has worked out a problem of extreme difficulty. Not only is the quantity to be measured extremely minute, but, unless very refined precautions are taken, it is certain to be disturbed beyond recognition by inevitable temperature changes. Mr. Nagaoka applied the principle of the gridiron-pendulum, and the remarkable smoothness of the curves which embody his results is an evidence of the perfection of the compensation. He has succeeded in proving and measuring the hysteresis in the magnetic-elongation cycle, and its broad character agrees perfectly with what might be inferred from the character of the hysteresis in the magnetic-twist cycle—a phenomenon whose experimental study is one of the simplest in the whole subject of magnetic strains. Papers on this subject by Mr. Nagaoka and Prof. Knott, may be consulted in the January number of the *Philosophical Magazine*.

THE OSCILLATIONS OF LIGHTNING DISCHARGES AND OF THE AURORA BOREALIS.

When air is subjected to a sudden strain at the moment of an electrical discharge, it behaves like glass or a similar elastic solid, and is "cracked" in zigzag fissures: there is great resemblance between the ramifications of lightning and the seams produced in plates of glass by pressure. Photographic evidence points to the conclusion that a lightning discharge makes way for its oscillations by first breaking down the resistance of the air by means of a disruptive pilot spark; and through the "hole" thus made in the air the subsequent surgings or oscillations take place. Some observers have contended that by rapidly moving a camera they have obtained evidence that successive discharges of lightning follow the same path; but Prof. Lodge protests against any conclusion drawn from this method, for the movement certainly requires the hundredth part of a second, whilst the lightning discharge is over in less than the hundred-thousandth of a second. The use of a revolving mirror probably affords the best means of studying the behaviour of air suddenly subjected to the electric strain, and Prof. Trowbridge has recently examined this behaviour with more powerful means than those employed by previous observers.

The alternating machine, combined with the transformer, enables one to investigate the character of lightning more successfully than is possible by means of any other electrical machine: for both the E.M.F. of the discharge and its quantity can be adjusted over a wide range. Prof. Trowbridge has used an alternating machine giving from 300 to 400 alternations per second with a current of from 15 to 20 ampères, and the photographic apparatus was the same as that which was used in his investigation on the damping of electrical oscillations on iron wires (*vide Phil. Mag.*, December, 1891). By means of a "step-up" transformer and an oil condenser, discharges of high E.M.F. and great quantity could be obtained. This method of the excitation of a Rhumkorff coil or transformer, by means of an alternating dynamo, due originally to Spottiswoode, has placed in the hands of the experimenter a powerful means of studying electrical discharges.

The study of the efficiency of "step-down" transformers in transforming transient currents of high potential to transient currents of low potential and comparatively large current, enables one to obtain an estimate of the high potential of lightning and of the current which accompanies its fall of potential. Thus, if C denotes the current in the discharge, and E the E.M.F., C′ and F′ the corresponding quantities in circuit of the primary of the "step-down" transformer, and A the efficiency of the transformer, we shall have

$$C' F' = A C E.$$

The element of time must be considered in any estimate of the amount of energy in lightning discharges.

Although a powerful spark of electricity from two Leyden jars, each of 5,000 electrostatic units, is incapable of decomposing water directly, yet, by its passage through the secondary of a suitable "step-down" transformer, it can decompose the water in the primary with great evolution of gases, and it is probable that an ordinary discharge of lightning of a few hundred feet in length could light, for an instant, many thousand incandescent lamps, if it were properly transformed by means of such a transformer. Indeed, the ringing of electrical bells and the melting of electrical fuses are of common occurrence during thunderstorms, and manifest the energy of lightning discharges.

The study of the disruption or oscillatory discharges of lightning is closely connected with that of the brush discharge, and that of the phenomenon of the aurora borealis, for the disruptive discharge, if it be oscillatory, ceases to be disruptive after a few hundred-thousandths of a second. This is shown by the evidence of Prof. Trowbridge's photographs; the zigzag fissures in the air disappear and only the spark terminals glow. Recent experimenters have exhibited, as a marvel, the lighting of a vacuum tube through the human body by grasping one terminal of a suitable transformer with one hand and by holding the vacuum tube in the other. It must be remembered, however, that the lines of force proceed from the hand which holds the tube through the air and the walls or floor of the room to the other terminal of the transformer. We can change this brush discharge or luminosity at either terminal of a transformer into a disruptive discharge by lessening the distance between the terminals or by increasing the E.M.F.

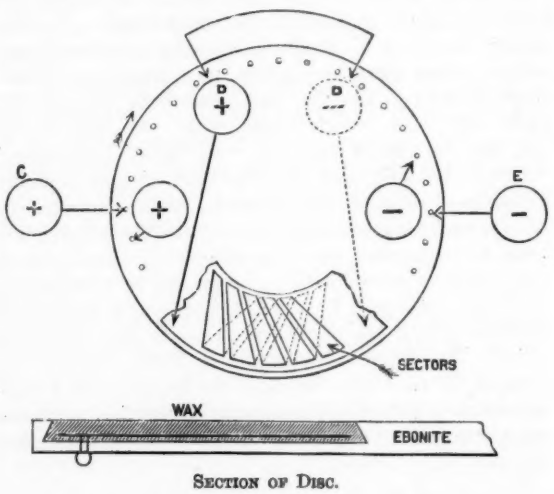
Without entering into a consideration of the molecular movements involved in oscillatory discharges in vacuum tubes, which might, perhaps, have been expected, Prof. Trowbridge, in the paper we are here noticing (*American Journal of Science*, Vol. xlvi., No. 273, September, 1893, pp. 195—201), endeavours to trace the connection between such discharges and the phenomena of the aurora borealis. To his mind, the luminosity in a vacuum tube held in one hand whilst the other grasps the terminal of a Rhumkorff coil closely resembles these phenomena, for there is, in this case, a discharge of electricity from a higher line to a lower through a rarefied medium. Incidentally we note that he demonstrates that the stratified discharge has no connection with the oscillatory discharge of electricity, such as we have been considering.

By insensible gradations we may pass from the condition of the brush discharge to that of the disruptive discharge; and Prof. Trowbridge gives reason for his opinion that the pulsation of the aurora borealis is in no way connected with any oscillatory discharge, and the supposition that it is produced by the action of extremely rapid electrical oscillations on molecules of rarefied air is not borne out by the theory of transient currents. Moreover, he shows, by experiment, that the phenomenon of the waving and apparent stratification observed at times in the aurora is due to the redistribution of the lines of force which is produced by suitable "earths" in the shape of regions of cloud and moisture. He sees no reason for believing in the rapid oscillation of the aurora.

AN INFLUENCE MACHINE.*

By W. R. PIDGEON.

If we follow the action of any single sector on a disc of one of Mr. Wimshurst's beautiful machines, we find it goes through the following electrical changes:—Suppose it



Section of Disc.

to be just leaving the positive collector, C, it comes into a strong positive field produced by the other disc, and while in this field is earthed by the first neutralising brush, D, and becomes charged negatively. Passing on it induces a positive charge on the other disc at the next neutralising brush, D′, and ultimately meets a similar negative charge, borne forward by the other disc, at E, where it discharges into the negative collector. I do not mean that this is a full explanation of all that takes place, but I hope by its means to show

* Read before the Physical Society, June 23rd, 1893; and briefly reported in the Electrical Review, August 11th, 1893.

the lines along which I worked in designing the machine before you. I thought that what had to be done was :—1. To make the capacity of each sector on the disc as great as possible while being charged at D, and as small as possible while being discharged at E, so that the amount of electricity displaced by each sector should be as large as possible. 2. To prevent any leak-back of electricity from sector to sector as they are entering or leaving the different fields of induction. 3. To make the sectors large and numerous so as to increase the capacity of the machine. And it was with these objects in view that I built the machine which I will now describe. The discs are made of ebonite, $\frac{5}{8}$ inch thick, and are recessed, as shown in the drawing, $\frac{3}{8}$ inch deep × $5\frac{3}{8}$ inches wide. There are 32 sectors on each disc made of thin sheet-brass, and having short brass wires soldered to them on to which the small brass collecting knobs are screwed. The sectors were arranged in the recess, as shown on the drawing, the wires attached to them were passed through holes in the disc, and the knobs screwed on from the back. The recess was then filled up to slightly above the level of the face of the disc with melted wax composed of equal parts by weight of paraffin and resin, and when cold the excess wax was turned off in the lathe. Each sector is thus entirely imbedded in an insulating material, the only exposed part, from which the charge might brush back from sector to sector, being the small brass knob. In order to minimise this possible leak, the sectors are set at an angle to any radius, as shown on the drawing, so that a sector on one disc does not pass a sector on the opposite one suddenly, but does so with a sort of shearing motion requiring four times the angular movement of the discs for the sectors to clear one another than would be needed were they placed radially. By the time, moreover, that any one sector has entirely entered a field of induction, the next following sector is three parts into the field, and the next behind that again is half in, while the third is one-fourth the way in, and the fourth just entering, so that the maximum difference of potential between any two neighbouring knobs is reduced to one-fourth of what it would be were the sectors arranged radially. This angular arrangement of the sectors naturally necessitates the collecting and neutralising brushes being displaced from the positions they would occupy were the sectors radial, so as to touch the latter at the right moment. In order to increase the capacity of each sector while receiving its charge, two stationary inductors are placed opposite each disc, one at each of the points where the sectors on that disc are earthed. Each inductor consists of a sheet of tin-foil embedded in wax and supported on a disc of ebonite, and is charged from a pin-point connected to it through an ebonite tube; this pin-point stands opposite to the outer knobs on another part of the large disc, where their sign and potential are such as are required to charge the inductor. Each sector at the moment of being earthed is thus placed between two similarly charged inductors—the sectors on the opposite disc on the one side and the fixed inductor on the other, each of which is large in comparison with itself; its capacity is thereby greatly increased and it is enabled to carry forward a much larger charge of electricity than it can when the stationary inductors are removed.

The effect produced on the output of the machine by using these stationary inductors is remarkable, for though they practically make no difference to the length of the sparks, they greatly increase their apparent thickness; and with other things precisely similar they increase their frequency three-fold. To compare the output of the machine with and without the stationary inductors, I counted the number of sparks which overflowed a Leyden jar, and the revolutions of the discs, for 30 seconds, both when using the inductors and when they were taken off, and I was careful, in every case, to keep the speed of the discs as nearly as possible constant. I thus found that a 25-ounce Leyden jar overflowed 19 times in 30 seconds without inductors and 54 times with them; or, making a slight correction for the revolutions of the discs being less in the second case, the output was increased as 3 to 1 by the use of the inductors. The explanation of this greatly increased output is, I think, to be sought in the fact that connecting the positive and negative terminals of this machine does not stop its action, as it does in the case of the Wimshurst machine, and that it is therefore ready to start sparking, with almost full vigour, the moment they are separated. For when the inductors are removed, and two or three Leyden jars connected to the terminals, it is perfectly easy to note the discharge of the discs with each spark, and the time they take to recover, slowly at first and very rapidly at last, depending on the size of the condensers they are charging; but when the fixed inductors are replaced the recovery is very much more rapid, especially in its early stages, owing, I think, to the fact that the inductors apparently do not lose their charge with each spark, and therefore, at once, start up the action of the machine.

With a view to decrease the capacity of each sector at the moment of its being discharged into the collector, I put on another set of inductors, one opposite to each of the main collecting brushes, and so arranged matters that they could be charged either from the neighbouring inductor or from the collector itself. In this way each sector at the moment of discharging itself into the collector is almost surrounded by a field of the same sign as itself, and I hoped by this means to squeeze more of its charge out of it as it passed. I was at first, however, disappointed to find that this second set of inductors made little if any difference to the output of the machine, whether they were connected to the other inductors or to the main collectors. But on arranging them to collect their own charge directly from the small knobs on the revolving discs, at a point just before the main collecting brushes, they became of value and increased the efficiency of the machine nearly one-fifth.

By the kindness of Mr. Wimshurst and Dr. Lewis Jones, I have been enabled to compare the output of my machine with that of a Wimshurst having eight 15-inch plates and also with one having two 16-inch plates. I find that, area for area, and without using the stationary inductors, the efficiency of my machine is to that of the Wimshurst as 3 to 2; and with the inductors in use it is as 5·64 to 1. That is, from 5 to $5\frac{3}{4}$ times the area of plate is required to pass the collector in the Wimshurst machine to that which must pass it in this machine to produce the same result; or, to give the figures as we took them together :—

	sq. ft.
Wimshurst's 8 plate 15-inch diam. machine requires of area to pass the collector per spark.	97·07
Jones's 2 plate 16-inch diam. Wimshurst requires ...	87·83
W. R. Pidgeon's 4 plate 24-in. diam. machine without inductors	63·64
W. R. Pidgeon's 4 plate 24-in. diam. machine with one set of inductors on	21·117
W. R. Pidgeon's 4 plate 24-in. diam. machine with both sets of inductors on	17·2

I feel I ought to mention a mistake I fell into, while working on this machine, which nearly made me think that fixed inductors were of no use. When first trying them I used brushes, instead of a single point, to collect their charge, and was disappointed to find the output of the machine reduced to almost *nil*, because, as I ultimately discovered, the brushes formed a bridge between the sector knobs and allowed the charge to flow back from sector to sector, instead of being carried forward to the collector. Another difficulty I have not been able to get over, and one which greatly decreases the actual output of the machine, is caused by the warping of the ebonite discs, which, although $\frac{5}{8}$-inch thick, will not stand true after being turned up, but move just sufficiently to throw them out of balance and prevent their being driven at anything approaching a high speed. The ebonite, moreover, is not a sufficiently good insulator, and not only prevents my getting a long spark, but also reduces the possible efficiency of the machine by becoming an increasingly good conductor as the potential rises.

DISCUSSION.

In a written communication Prof. O. LODGE said his assistant, Mr. E. E. Robinson, constructed a machine on lines similar to Mr. Pidgeon's, a few months ago, and had now a large one nearly completed. Mr. Robinson's fixed inductors are carried on a third plate fixed between the two movable ones. The sectors are quite small, and neither they nor the inductors are embedded. On close circuit the machine gives a large current ($\frac{1}{1000}$ ampère) and on open circuit exceedingly high potentials. In Dr. Lodge's opinion Mr. Pidgeon attaches too much importance to his sectors and their shape.

Mr. J. GRAY wrote to say that stationary inductors enclosed in insulating material would probably give trouble at high voltages, because of the surface of the insulator becoming charged with electricity of opposite sign to that on the in-

ductor He suggested that this might explain why Mr. Pidgeon could not obtain very long sparks.

Prof. C. V. BOYS enquired as to how far the wax made insulating union with the ebonite, for, if good, glass might possibly be used instead of ebonite. He greatly appreciated the design of Mr. Pidgeon's machine

After some remarks by the PRESIDENT, on the great advances which had been made, Mr. PIDGEON replied, and Mr. Wimshurst tried some further experiments with a small experimental machine.

A NEW FORM OF INFLUENCE MACHINE.*

BY JAMES WIMSHURST.

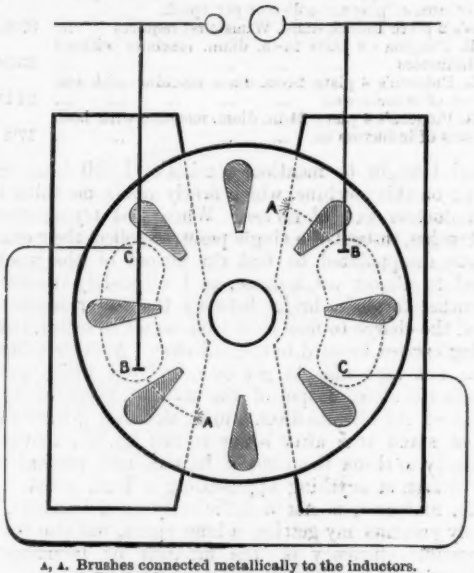
IN April, 1891, I had the honour to submit to this meeting a very useful form of experimental influence-machine, by means of which I was able to show that almost every combination of glass and metal, and also that plain glass discs, when moved and suitably touched, were capable of producing a flow of electricity.

It is one of those combinations, somewhat modified and extended, which I have now the further pleasure of bringing to your notice.

The machine consists of two discs of plate-glass, each of 3 feet 5 inches diameter and $\frac{1}{8}$ inch thickness, mounted about $\frac{3}{4}$ inch apart on one boss and spindle. This spindle is driven by means of a handle, and the discs rotate in one direction.

In the space between the discs are fitted four vertical slips of glass, two being situated on the right-hand side of the machine and two on the left-hand.

The vertical edges of the slips which come nearest the spindle are cut to an angle, leaving a rather wider opening at the circumference than at the centre of the disc. Upon



A, A. Brushes connected metallically to the inductors.
B, B. Collecting-brushes connected with terminals.
C, C. Brushes connected with the neutralising circuit.

each slip is a brush, A, and also an inductor, the brush and the inductor being metallically connected; the brushes are made of fine wire, and touch very lightly on the inner surfaces of the discs. The glass slips slide into place by means of suitable grooves at their top and bottom ends; they may be removed and replaced readily at pleasure.

The essential parts are fitted together within a glass case, and in all respects the machine is so constructed as to be useful for experimental work. The limited size of the case causes the insulating distances between part and part to be small, hence the length of the sparks is reduced. All the surfaces are coated with shellac, and when the brushes are new and in proper condition the machine is self-exciting.

The charges are not subject to reversal when the terminals are opened beyond the striking distance, for then the whole of the induced charges pass by way of the neutralising brushes, C, C. Another feature is that the neutralising current may also be broken without reducing the excitement, but then the charges alternate from positive to negative with each half revolution of the discs.

An approximate measure of the efficiency of the machine is seen by the following experiments.

The glass throughout was held free from electrical excitement, and the discs were rotated 60 times per minute; the actuating cause was then removed, and the discs came to rest after making 47 revolutions. This measures the friction of the machine.

The discs were then similarly turned, but the electrical charges were allowed to collect; it was then found that the discs came to rest after 23 revolutions. The friction of the machine, therefore, is about equal to the repulsion of the electrical charges.

Leyden jars, having eight square inches of tinfoil in each coating, were then connected to the terminals, and the terminals set $3\frac{1}{2}$ inches apart: the discs were turned to the same number of revolutions and then left to come to rest, which they did after producing 80 sparks.

The discs were then turned and the number of sparks counted in relation to each revolution. This gave seven sparks of 1 inch in length, five of 2 inches, four of 3 inches, and three of $4\frac{1}{2}$ inches length.

Eight metal sectors were then added (total 112 square inches on each disc): with them the self-excitement becomes so free that, before any circuit was made, presenting the fingers to the discs caused electrical discharges.

When the circuits are made between the several brushes the discs appear to be seething with electricity, and the charges shoot out for a considerable part of their circumference, but chiefly at the top and the bottom, where they are not covered by the vertical glass slips, for the change of the charges from + to − takes place upon the discs just as they pass the edge of the slip. Improvements in this respect might be made, but the present arrangement has the advantage of giving permanence to the respective charges.

It will be noticed that strips of tinfoil are placed over the receding surfaces of the glass slips. They were intended to afford the means for collecting and carrying to earth any part of the charges from the inductors, but the earth connection has not been necessary.

When at work, the charges passing from the discs to the brushes may be heard some considerable distance; they resemble the beating of the floats of a paddle wheel.

The charges are, however, reduced about 25 per cent. by the addition of the sectors.

Further tests have been made by fixing a pulley, 3 inches in diameter, to the overhanging end of the spindle, and suspending therefrom by a cord a weight of 15 lbs. The fall of this weight through 3 feet produced 17 revolutions when the discs were not excited and 10 revolutions when excited. The same Leyden jars were then connected, and it was found that the fall of the weight through 3 feet produced 28 sparks of $3\frac{1}{2}$ inches length. Reducing this to the terms of work in relation to sparking length, and omitting friction of the machine, it will be seen that 1 lb. weight falling through rather less than 12 inches produces a spark of $3\frac{1}{2}$ inches length. It must not, however, be forgotten that a considerable amount of electricity is also passing by way of the neutralising circuit.

* Read June 23rd, 1893, before the Physical Society, and briefly reported in the ELECTRICAL REVIEW, August 11th, 1893.

THE MOST ECONOMICAL AGE OF INCANDESCENT LAMPS.*

BY LIEUT. MANNING K. EYRE, U.S.N.

IT is something fearful to see the lamentable ignorance displayed by the management of many large central stations and innumerable isolated plants as regards the most economical use of that small appliance which all these plants are mainly installed to operate; namely, the incandescent lamp.

* We are indebted to the editors of the *Electrical World* for an advance proof of this article.

Knowledge concerning this useful article finds its way slowly into the mind of the central station manager, and, apparently, not at all into that of the average consumer.

The subject to be discussed in this paper, namely, the advisability of renewing lamps after a comparatively short period of their life, is so well known that it would seem useless to attempt anything original. Mr. Carl Hering has covered the ground most thoroughly in an article entitled "The Most Economical Age of Incandescent Lamps," which appeared in the *Transactions of the American Institute of Electrical Engineers*, February, 1893. It is proposed to

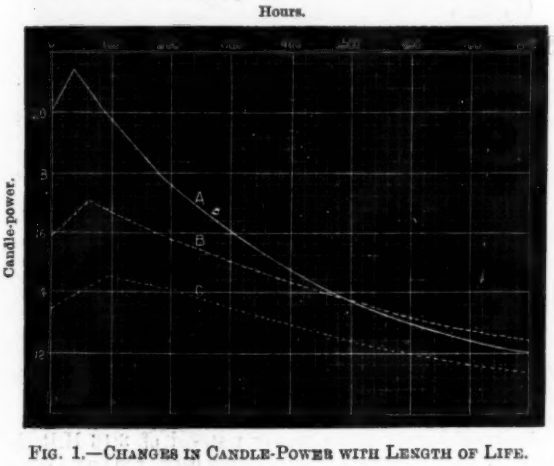


Fig. 1.—Changes in Candle-Power with Length of Life.

take up the subject in the first part of this article from a purely commercial standpoint and put the facts in such a shape that they will be readily understood. The latter part of the article will deal with the subject more mathematically and, perhaps, less interestingly; but, it is hoped, may prove of some value to technical readers.

The present method seems to be for a central station furnishing renewals to renew a lamp only when broken, or when it has dropped so much in candle-power that the patience of the user is exhausted. How can it be proved to the average station manager that this is bad, hopelessly bad policy? He will tell you that he is using less current per

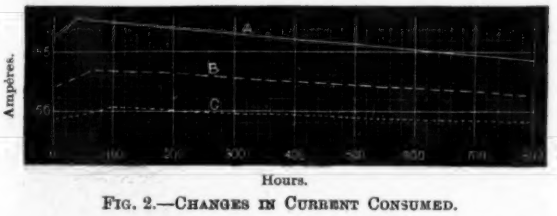


Fig. 2.—Changes in Current Consumed.

lamp (although in many cases he is using more), and, as long as the customer does not growl, it is money in his pocket to run a lamp on *ad infinitum*. It does not take more than average intelligence to see that even from his own incorrect standpoint he loses, and loses largely. What is he competing with? What does he want? He is competing with gas and he wants more custom. If he would adopt the policy of giving his customers far better light, it would not be necessary to make a deal with the local gas company, as he would soon have all the custom he wants.

Every user of lamps, be he central station, isolated plant, or ordinary customer, should break his lamp and renew it at such a time in its life that the cost per candle of light is least for the time the lamp has been used. Not the cost per lamp, but the cost per candle-power. This is self-evident.

We are buying light, and we are buying it by the candle-power, not by the lamp. We pay so much for 16 candles of light and so much more for 32 candles, and yet a user will start out with 32 candles of light that he has paid for, and he will keep right on paying for them when he is only getting 16 or 20 candles. To show the incorrectness of the station man's point of view, it is only necessary to glance at the curves showing the changes in current consumed, as shown in fig. 2. As the voltage remains constant, and since (as a glance at the curves will show) the current throughout the 800 hours is practically the same as at the commencement of the lamp's life, the total energy imparted to the lamp throughout any period of 800 hours or less is practically constant. As a matter of fact, up to 500 hours, the mean energy consumed by the lamp is greater than the energy at the start. In actual figures, at 300 hours, the total energy being expended is 63 1-2 watts, as against 62 watts when the lamp was brand new. So, that with one watt more energy, we are getting four C.P. less light.

It is very evident that the advisability of breaking and renewing lamps early in their life is greater in localities where power is more expensive and less where power is cheaper; we must take, therefore, comparatively wide limits for the cost of power in order to completely cover the ground. The less the value assumed for the cost of power, the stronger will the argument be against breaking the lamps. But, in order to leave no shadow of doubt in the mind of

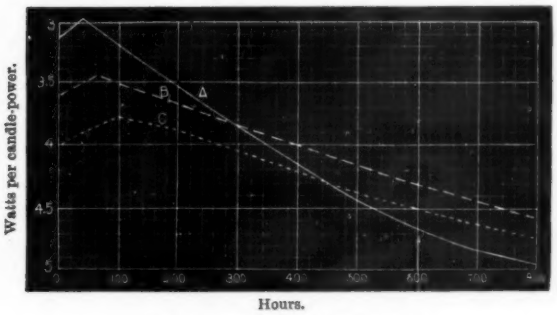


Fig. 3.—Changes in Efficiency.

any user of lamps that there is some point in the life of the lamp where it is advisable to break it, and beyond which point it is actual loss to him to run it, the lowest cost of power assumed is such that it must appeal to even those who pay very little for the current they supply or receive. The assumed costs, above referred to, are three cents, five cents, and eight cents per electrical horse-power hour delivered at the lamp; three cents is undoubtedly very low and eight cents is not high; consequently, I have erred, if at all, on the conservative side. The cost of a lamp will be taken as constant throughout the calculations—35 cents.

The data used in the following table are the mean of a large number of careful experiments made by Prof. B. F. Thomas, and the results of which were published in the *Transactions of the American Institute* for May and June, 1892. The average candle-power and efficiency are calculated from the data in the last column of Table V. of that paper. It must be remembered that all these results are the average of thirteen different makes of lamps, bought in the open market and carefully tested. It is presumable, therefore, that results based on these experiments will be commercially true.

The following table is an extract from the experiments referred to, on which all the calculations made in the construction of Table II. are based:

Table I.

Life.	Percentage of candle-power.	Watts per candle or efficiency.
0 hours...	100	4·2
100 „	95·6	4·5
200 „	90	4·8
300 „	84	5·0
400 „	78·4	5·3
500 „	73	5·6
600 „	68·6	5·9
700 „	64·7	6·3
800 „	62	6·6
900 „	57·4	6·8
1,000 „ ... 1·05 ... 11·6	·77 1·22	1·90

From the above table it is at once seen that the curve expressing the relation between watts per candle, or efficiency and the life of the lamp, is nearly a straight line, or, in simpler language, the efficiency decreases very nearly ·3 watt for every 100 hours of the life of the lamp; consequently,

the mean efficiency throughout any part of the lamp's life can be readily found.

I have taken a period of 3,000 hours and calculated in the following manner how much it would cost the user of light per candle for that time if he broke his lamps at 300 hours, 400 hours, or 500 hours, &c. Lamp cost, as stated above, 35 cents.

Case I.—If renewed at 300 hours.

Mean efficiency during 300 hours (see Table D.) = 4·6 w.
Mean candle-power during 300 hours ... ... = 14·9 c.p.

Since lamp is renewed 10 times in 3,000 hours :

Lamp, cost for 1 light, 10 × 35 ... ... = $3.50
Cost of power for 3,000 hours, for 1 lamp at 3 c. per E.H.P. hour $\frac{3 \times 3{,}000 \times 4{\cdot}6 \times 14{\cdot}9}{746}$ ... = 8.10

Total cost of lamp for 3,000 hours ... $11.60
Cost per C.P. of light, 3,000 hours $\frac{11{\cdot}60}{14{\cdot}9}$ ... = ·77

The above process is simply repeated for 400, 500,1600, &c., hours, and the result tabulated in column 4 of Table II. Columns 5 and 6 of Table II. are like results for costs of power of 5 cents and 8 cents :

Table II.

Lamp smashed at	Total cost.	Mean C.P. for 3,000 hrs.	Cost of one candle of light for 3,000 hours. When E.H.P. costs,		
			3c.	5c.	8c.
200 hours	$5·25	15·2	$0·88	$1·25	$1·79
300 ,,	3·50	15·	·77	1·14	1·69
400 ,,	2·62	14·4	·75	1·13	1·69
500 ,,	2·10	13·9	·75	1·13	1·71
600 ,,	1·75	13·4	·75	1·14	1·73
700 ,,	1·50	12·9	·745	1·15	1·76
800 ,,	1·32	12·5	·745	1·17	1·81
900 ,,	1·17	12·	·76	1·19	1·85
1,000 ,,	11·6	11·6	·77	1·22	1·90

(To be continued.)

EXPERIMENTS ON BROWN'S ASYNCHRONOUS MOTORS.*

By A. Banti.

(*Continued from page* 668, *Vol.* 33.)

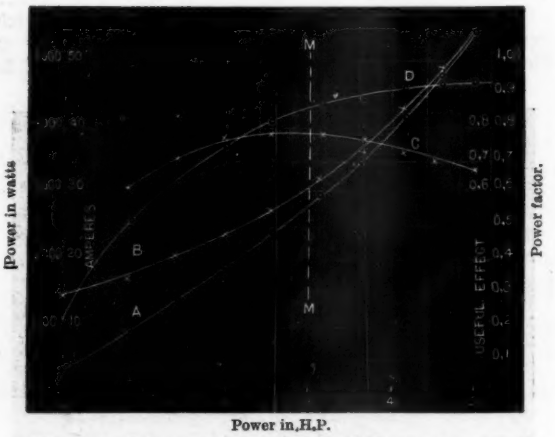
Another series of experiments, which were executed with more regularity, is summarised in Table II., which I have utilised for tracing the curve of fig. 2.

Watts consumed.	Ampères required at 106·3 volts.	Velocity, rotations at 1'.	H.P. recovered from the motor, c.	Useful effect $\frac{c \times 735{\cdot}5}{\text{watt}}$	Power factor $\frac{\text{watt}}{\text{volt} \times \text{amp.}}$	Angular power factor $\phi°$.	Apparent percentage of energy on real energy $100\frac{V \times A - W}{W}$
343·0	15·0	902	...	...	0·215	77°. 30′	364·86
967·7	17·5	890	0·82	0·62	0·521	58°. 40′	92·23
1421·0	21·0	870	1·38	0·71	9·637	50°. 30′	57·09
1911·0	24·0	884	2·01	0·77	0·751	41°. 20′	33·44
2401·0	27·5	872	2·54	0·78	0·819	35°. 00	21·75
2976·7	32·3	872	3·16	0·78	0·869	29°. 40	13·54
3503·5	37·0	860	3·67	0·77	0·892	26°. 50′	12·26
4189·5	43·0	868	4·19	0·73	0·917	23°. 30′	9·10
4806·9	48·5	848	4·60	0·71	0·934	21°.00	7·25
5439·9	55·0	860	5·07	0·68	0·934	21°. 00	7·49

For the different amounts of work which the motor serves the curve, A, indicates the watts consumed ; B, the ampères required at constant power, therefore the volts × ampères, C the commercial yield or useful effect of the motor ; D the power factor.

* In publishing the first portion of this paper in our issue for December 22nd, 1893, we omitted to state that these experiments are the subject of a paper by A. Banti, of which this article is a translation.—Eds. Elec. Rev.]

A resistance, M, M, parallel to the axis of the ordinate, and corresponding to an abscis equal to 3 H.P., divides the field in the figure into two ; that to the left refers to the ordinary work which the motor ought to develop ; that to the right refers to the case in which it is over loaded. Both in one field, and in the other the curve of fig. 3, manifests a behaviour of the motor as regular as worthy of attention.



Power in H.P.

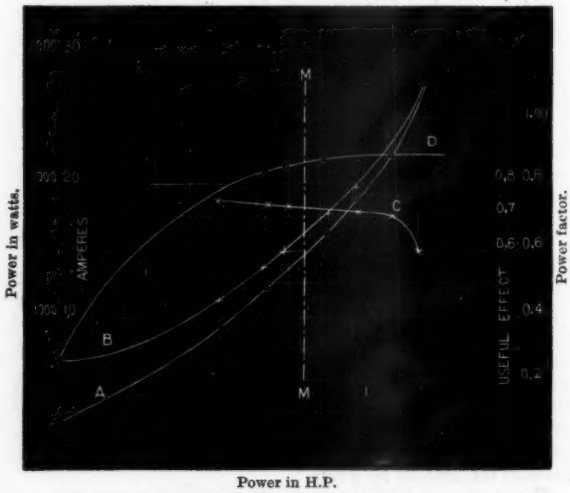
A, watts consumed ; B, ampères required ; C, useful effect D, power in watts.

Fig. 2.

As it will be seen at the power restored of 3·16 H.P. the useful effect is greatest and is 78 per cent., the angle of removal of the phase is 29°. 40, and the percentage of the effective energy on the apparent energy is 13·5.

The motor was arranged to drive 5·07 H.P., and in this case it did not lose its velocity, which varies between the limits of 5 per cent. from the action when unburdened and when over burdened.

All this comes to demonstrate that the objection of which we have made mention in principle is not found to be confirmed within the limits of our experiments. We may further add that such a motor likewise can overcome forces much superior to those for which it was constructed.



Power in H.P.

A, watts consumed ; B, ampères required ; C, useful effect ; D, power in watts.

Fig. 3.

The curve, A and B, of the watts and the ampères has a constant potential which gives a material proof of the difference between the apparent and the real energy. The difference is greatest when the motor runs free, and so much the less the greater is the work produced. This fact, which forms one of the gravest defects of the multiphase motors, occurs also to some extent in the Brown motors. The last column of Table II. makes it appear that when the motor gives 2·01 H.P., the percentage of apparent energy is from 33, and for 1·38 H.P. it ascends to 57.

The fact is particularly verified during the running of the

motor. At the beginning when the two coils of the motor are in circuit the ampères required at 106 volts are 55; they then decrease gradually to 42, and remain constant at this value, until the circuit is interrupted.

All this signifies that for a motor which ought in general to develop from 2 to 3 H.P. there is required to feed it a transformer of about 6,000 watts.

(*To be concluded.*)

THE ELECTRICAL EFFECTS AT THE LYCEUM THEATRE.

CINDERELLA UP-TO-DATE.

OLD and young should be interested in the fact that Cinderella is in the van of progress. On each recurring visit she is more modernised and more in touch with this scientific age. The older she grows the more charming she becomes; to-day she has enlisted electricity in her service, and has become more resplendent and more beautiful than ever.

We are not going to tell the tale of Cinderella, nor to recite how Mr. Horace Lennard has treated the well known theme in Mr. Oscar Barrett's pantomime at the Lyceum Theatre. Suffice to say we went recently to witness the electrical effects, and were astonished, not only at the ingenuity displayed in adjusting the electrical fittings to the necessity of the piece, but the pantomime itself charmed us, and though technical journalists are not usually allowed to express an opinion upon the beauties of stage production, we cannot refrain from expressing our admiration of Mr. Barrett's excellent staging.

Scene 1 is the Factories of Fairyland, and to the astonished public is revealed two glass slippers on a cushion, illuminated in a most marvellous manner. As to how this effect is obtained, we must refer electrical men to the piece, and we think they could solve the mystery.

Passing rapidly to the other scenes, omitting, but not forgetting, Miss Ellaline Terriss's representation of Cinderella, and Miss Kate Chard's singing, we come to the Kitchen at the Baron's, where Cinderella is "discovered" alternately stirring up a fire and a savoury mess in a gipsy kettle.

The fire in this scene is lighted by a cluster of ruby-coloured lamps. Then comes a vision over the fire, which is made effective by means of a 100 C.P. 100-volt lamp, with a resistance in circuit which gradually brings the lamps from a state of non-luminosity to full incandescence, and then gradually reduces same.

Then the Fairy Boudoir, where the electrical effects are numerous, two enormous and pantomimic candles in this scene are each supplied with 100-volt 100 C.P. lamps, contact with the mains being established by means of wall-plugs let in the stage.

The scent bottle, about the size of a small conservatory, has 11 concealed lamps fixed inside, each lamp being of 25 C.P., and being coloured so as to imitate prismatic effects on the bottle. The fairy slippers, electrically lighted, are here brought in again, and we have a delightful effect, marred, to us, by worrying thoughts as to whether it will last.

Then the time comes when Cinderella must proceed to the ball, and immediately she takes her seat in the small carriage the wheels literally burst into light. Perhaps we should be giving away secrets if we were to say how this is done, but the effect on the public is most marked, and they do not forget to notify the fact.

Our story takes us, as the novelists say, to the Grounds of the Royal Palace. In this scene the entrance to the palace is decorated with imitation floral sprays. There are 26 sprays, each having lamps to represent flowers. The largest number of lamps on any spray is 10, and the smallest five. On each spray three kinds of lamps are used, viz., an Edison-Swan 100-volt 8-C.P., with small bulb and miniature shoe; an Edison-Swan 100-volt 8-C.P., with small bulb and ordinary shoe, and an ordinary 100-volt 8-C.P. lamp. The small lamps are arranged at the top of the spray, and represent the buds of the flowers. Lower down are placed larger lamps, which represent the flower just opening, and still lower down are still larger lamps, representing the flowers nearly in full bloom, while at the bottom big lamps are used to produce the effects of full blown flowers. Each lamp is covered with a wire frame, which is again covered with silk, to represent the colour and shape of the flower which it is desired to produce. Each spray is mounted in a conical metal shoe, which slips into a socket fixed to the main connecting wires which are run on the scenery. The junctions are made in all cases by means of flexible wires and wall plugs. The base of the Palace scene is electrically divided into nine sections, which are joined by means of flexible wire and wall plugs. The wires on the movable scenery terminate in a fireproof junction box, fixed centrally on the back of the scene. The current from the mains is led up on to the stage on the prompter's side, each lead being provided with a separate switch. The wires then go down again under the stage, and run to the back, where they terminate in a fireproof junction box let into the stage floor. Stout cable, capable of carrying 100 ampères, joins the floor box to the junction box on the movable machinery. Each of the 26 sprays have to be fixed and removed each time the scene is set; all the connections between the parts of the base also have to be electrically connected up. This represents a piece of very sharp work, as 10 minutes only are allowed for setting up the scene, and from 7 to 10 minutes for removing it. All this, however, is a very prosaic way of describing one of the most beautiful scenes ever placed on the stage.

At the termination of Scene 7 the stage is darkened, and the electrically-lighted slipper is discovered. In this case the slipper is supplied with three 2½-C.P. lamps, and is fed from a battery in the wings, connection being made by means of flexible cord.

The whole of the electrical fittings used on the stage in this pantomime have been made by the Lithanode and General Electric Company, who, under the supervision of Mr. Niblett, the general manager, have installed and are maintaining the thing for Mr. Oscar Barrett.

Considering the rough and tumble conditions which surround the electrical fittings, it is quite a revelation that such marvellous effects should be obtained without failures and without risks of fire.

THE TESLA ELECTRICAL OSCILLATOR.

WE are indebted to the editors of the *Electrical Engineer*, of New York, for an advance proof of the following article:—

In the lecture delivered before the Chicago Electrical Congress, Mr. Nikola Tesla first drew attention * to the method and means which he had devised for the continuous production of alternating currents of constant period and in which all rotating parts are avoided by the employment of his oscillating engine directly to the movement of the generating coil in the magnetic field.

The main reason why no engine heretofore has been capable of producing results of this nature, is that it has been customary to connect with the reciprocating parts a heavy fly-wheel, or some equivalent rotary system of relatively very great inertia, or in other cases where no rotary system was employed, as in certain reciprocating engines or tools, no regard has been paid to the obtainment of the conditions essential to the end which Mr. Tesla had in view.

In applying the Tesla oscillator for the generation of currents of constant period, certain conditions are encountered which must be taken into consideration in order to satisfactorily secure the desired result. When a conductor is moved in a magnetic field and a current caused to circulate therein, the electro-magnetic reaction between it and the field might disturb the mechanical oscillation to such an extent as to throw it out of isochronism. This, for instance, might occur when the electro-magnetic reaction is very great in comparison to the power of the engine, and there is a retardation of the current so that the electro-magnetic reaction might have an effect similar to that which would result from a variation of the tension of the spring, but if the circuit of the generator be adjusted so that the phases of the electromotive force and current coincide in time, that is to say, when the current is not retarded, then the generator driven by the engine acts merely as a fractional resistance and will not, as a

* See the New York *Electrical Engineer*, August 30th, 1893; and the ELECTRICAL REVIEW, December 29th, 1893.

rule, alter the period of the mechanical vibration, although it may its amplitude. This condition may be readily secured by properly proportioning the self-induction and capacity of the circuit, including the generator.

Mr. Tesla, has however, observed the further fact in connection with the use of such engines as a means for running a generator, that it is advantageous that the period of the engine and the natural period of electrical vibration of the generator should be the same, as in such case the best conditions for electrical resonance are established and the possibility of disturbing the period of mechanical vibrations is reduced to a minimum. Mr. Tesla has found that even if the theoretical conditions necessary for maintaining a constant period in the engine itself are not exactly maintained, still the engine and generator combined will vibrate at a constant period. For example, if instead of using in the engine an independent cylinder and plunger, as an air spring of practically constant rigidity, the piston may impinge upon air cushions at the ends of its own cylinder. Although the rigidity of such cushions or springs might be considerably affected and varied by the variations of pressure within the cylinder, still by combining with such an engine a generator which has a period of its own, approximately that of the engine, constant vibration may be maintained even through a considerable range of varying pressure, owing to the controlling action of the electro-magnetic system.

Indeed, Mr. Tesla has even found that under certain conditions the influence of the electro-magnetic system may be made so great as to entirely control the period of the mechanical vibration within wide limits of varying pressure. This is likely to occur in those instances where the power of the engine while fully capable of maintaining a vibration once started, is not sufficient to change its rate.

In our issue of November 8th, 1893, we gave the details of construction of the Tesla oscillator, and a patent just issued to Mr. Tesla, now enables us to supplement our previous descriptions with those of other types employed by him in this work. The accompanying engraving, fig. 1, is a sectional view of an oscillator fulfilling the conditions laid down above.

Referring to fig. 1, A is the main cylinder in which works a piston, B. Inlet ports, C, C, pass through the sides of the cylinder opening at the middle and on opposite sides. Exhaust ports, D, D, extend through the walls of the cylinder and are formed with branches that open into the interior of the cylinder on each side of the inlet ports and on opposite sides of the cylinder. The piston, B, has two circumferential grooves, E, F, which communicate through openings, G, in the piston with the cylinder on opposite sides of the piston respectively.

The particular construction of the cylinder, the piston and the ports controlling it, may be very much varied, and is not in itself material, except that in the special case under consideration it is desirable that all the ports, and more especially the exhaust ports, should be made very much larger than is usually the case, so that no force due to the action of the steam or compressed air will tend to retard or affect the return of the piston in either direction.

The piston, B, is secured to a piston rod, H, which works in suitable stuffing boxes in the heads of the cylinder, A. This rod is prolonged on one side and extends through bearing, V, in a cylinder, I, mounted in line with the first, and within

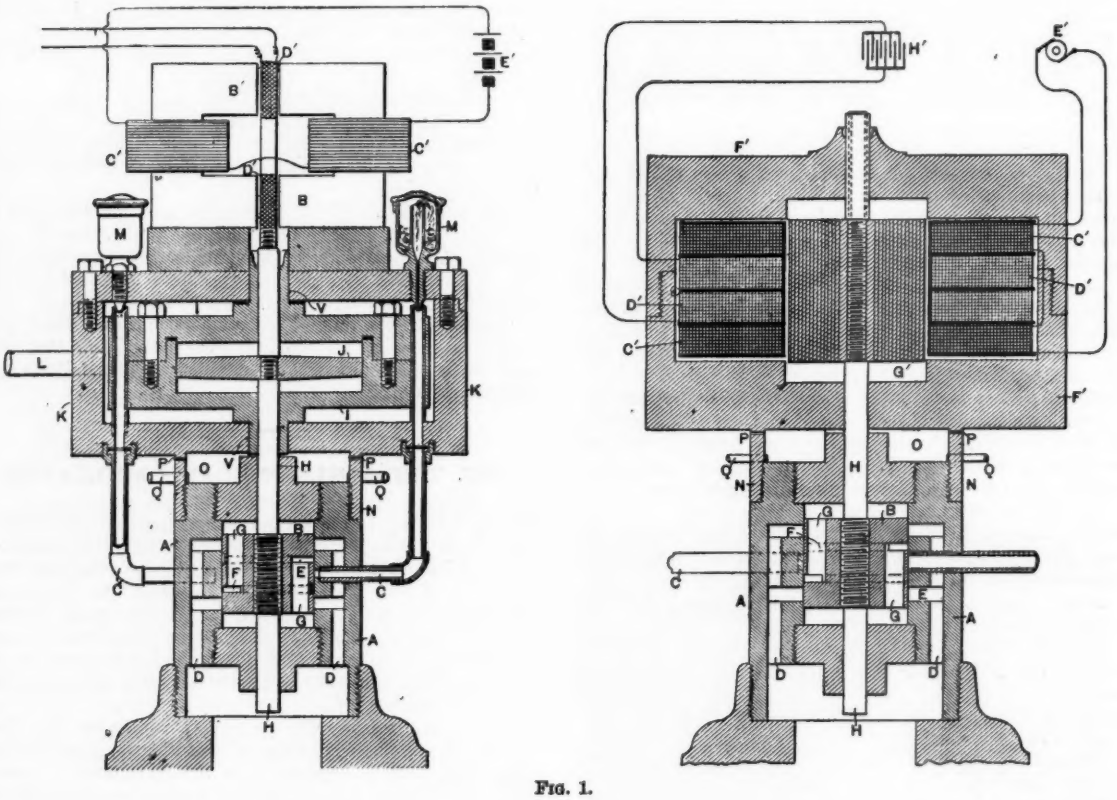


Fig. 1.

which is a disc or plunger, J, carried by the rod, H. The cylinder, I, is without parts of any kind and is airtight, except as a small leakage may occur through the bearings, V, which experience has shown need not be fitted with any very considerable accuracy.

The cylinder, I, is surrounded by a jacket, K, which leaves an open space or chamber around it. The bearings, V, in the cylinder, extend through the jacket to the outside air and the chamber between the cylinder and jacket is made steam or airtight by a suitable packing. The main supply pipe, L, for steam or compressed air leads into this chamber, and the two pipes that lead to cylinder, A, run from this chamber, oil cups, M, being conveniently arranged to deliver oil into the pipes for lubricating the piston.

In the particular form of engine shown, the jacket, K, which contains the cylinder, I, is provided with a flange, N, by which it is screwed to the end of the cylinder, A. A small chamber, O, is thus formed which has air vents, P, in its sides, and drip pipes, Q, leading out from it, through which the oil which collects in it is carried off.

In the position of the parts shown, or when the piston is

at the middle point of its stroke, the plunger, J, is at the centre of the cylinder, I, and the air on both sides of the same is at the normal pressure of the outside atmosphere. If a source of steam or compressed air be then connected to the inlet ports, C, C, of the cylinder, A, and a movement be imparted to the piston as by a sudden blow, the latter begins to reciprocate in the well-known way.

The movements of the piston compress and rarefy the air in the cylinder, I, at opposite ends, alternately. A forward stroke compresses the air ahead of the plunger, J, which acts as a spring to return it; similarly, on the back stroke the air is compressed on the opposite side of the plunger, J, and tends to drive it forward.

The compressions of the air in the cylinder, I, and the consequent loss of energy, due mainly to the imperfect elasticity of the air, give rise to a very considerable amount of heat. This heat is utilised by conducting the steam or compressed air to the engine cylinder through the chamber formed by the jacket surrounding the air-spring cylinder; the heat thus taken up and used to raise the temperature of the steam or air acting upon the piston is availed of to increase the efficiency of the engine.

In any given engine of this kind the normal pressure will produce a stroke of determined length, and this will be increased or diminished according to the increase of pressure above, or the reduction of pressure below, the normal. In constructing the apparatus, proper allowance is made for a variation in the length of stroke by giving to the confining cylinder, I, of the air-spring properly determined dimensions. The greater the pressure upon the piston, the higher will be the degree of compression of the air-spring, and the consequent counteracting force upon the plunger.

The rate or period of reciprocation of the piston, however, is mainly determined by the rigidity of the air spring and the inertia of the moving system, and any period of oscillation within very wide limits may be secured by properly portioning these factors, as by varying the dimensions of the air chamber, which is equivalent to varying the rigidity of the spring, or by adjusting the weight of the moving parts. These conditions are all readily determinable, and an engine constructed as above described maintains a perfectly uniform period through very wide limits of pressure.

The pressure of the air confined in the cylinder when the plunger, I, is in its central position, will always be practically that of the surrounding atmosphere, for while the cylinder is so constructed as not to permit such sudden escape of air as to sensibly impair or modify the action of the air spring, there will still be a slow leakage of air into or out of it around the piston rod according to the pressure therein, so that the pressure of the air on opposite sides of the plunger will always tend to remain at that of the outside atmosphere.

To the piston rod, H, is secured a coil, D′, which, by the movements of the piston, is oscillated in the magnetic field produced by two magnets, B′, B′, which may be permanent magnets or energised by coils, C′, C′, connected with a source of continuous current, E′. The movement of the coil, D′ across the lines of force established by the magnets gives rise to alternating currents in the coil. These currents, if the period of mechanical oscillation be constant, will be of constant period.

In the case under consideration, it is assumed as a necessary condition that the inertia of the movable element of the generator and the electro-magnetic reaction which it exerts, will not be of such a character as to materially disturb the action of the engine.

Fig. 2 is an example of a combination in which the engine is not of itself capable of determining entirely the period of oscillation, but in which the generator contributes to this end. In this figure the engine is the same as that shown in fig. 1. The exterior air spring is, however, omitted, and the air spaces at the ends of the cylinder, A, relied on for accomplishing the same purpose. As the pressure in these spaces is liable to variations from variations in the steam or gas used in impelling the piston, they might affect the period of oscillation, and the conditions are not as stable and certain as in the case of an engine constructed as in fig. 1. But if the natural period of vibration of the elastic system be made to approximately accord with the average period of the engine, such tendencies to variation are very largely overcome, and the engine will preserve its period, even through a considerable range of variation of pressure.

The generator in this case is composed of a magnetic casing, F′, in which a laminated core, G′, secured to the piston rod, H, is caused to vibrate. Surrounding the plunger are two exciting coils, C′, C′, and one or more induced coils, D′, D′. The coils, C′, C′, are connected with a generator of continuous currents, E′, and are wound to produce consequent poles in the core, G′. Any movement of the latter will therefore shift the lines of force through coils, D′, D′, and produce currents therein.

In the circuit of coils, D′, is shown a condenser, H′. By the use of a proper condenser the self-induction of this circuit may be neutralised. Such a circuit will have a certain natural period of vibration, and, as this depends upon the capacity and self-induction, the period may be varied to approximately accord with the period of the engine.

In case the power of the engine be comparatively small, as when the pressure is applied through a very small fraction of the total stroke, the electrical vibration will tend to control the period, and it is clear that if the character of such vibration be not very widely different from the average period of vibration of the engine under ordinary working conditions, that such control may be entirely adequate to produce the desired results.

A PILLAR OF SCIENCE.*

The "Personal Recollections of Werner von Siemens" was without doubt the most important electrical publication of 1893. It is a book which cannot be reviewed hastily, and then be summarily dismissed in a few brief sentences. Apart from the personality of Siemens, the historic value of these memoirs are of the greatest value, in that they rescue from oblivion the names of men who bore a gallant part in the pioneering days of electricity, when those who sought to know something of electricity were like mariners, without compass, on the trackless ocean, striving, stumbling, hoping, yet accomplishing much. Of the internecine struggles of the divided German States, and the outward assaults of enemies, we learn a good deal, for Siemens was not only a scientist, he was a soldier and a patriot. A careful perusal will reveal many of the forces which went to influence and to mould the mind of a famous scientist. The lesson of how, without extraneous help, without much teaching, Siemens fought his way to the topmost rung of the ladder, should be a great and lasting one. Unfortunately, the climbing of the ladder of fame has with smart young men fallen into disrepute, and the name of Dr. Smiles too often raises a sneer. Still, if precept go for anything—if in these days of degenerate snobbery the gospel of self-help find a responsive echo in a young man's mind—to him this book can be recommended. To electrical men, however, the life and thoughts of Werner Siemens are more than this. They alone can appreciate the picture of Siemens endeavouring to carry out practical applications at a time when electricity was imperfectly known, when its laws had scarcely been enunciated, and when the knowledge of most men did not exceed that comprised in the first page of a modern text-book.

Before passing on to the more stirring events of his life, we will touch briefly upon the early history of Siemens. Much of this is already known, but a readier conception of his after life will be gained by considering a few incidents of his childhood. Until Werner was eight years old, his father farmed the Obergat estate at Lenthe, in Hanover. It was here that Werner, at five years of age, gained a signal victory in battle with a gander, and this occurrence, trifling and ludicrous as it may seem, had, according to Werner, a marked effect on the character of the victor. The elder Siemens was, apparently, a man of fair education. "He belonged with heart and soul to that section of young Germany which, growing up amid the storms of the great French Revolution, was enthusiastic for freedom and a united Fatherland." He had almost fallen into the hands of Napoleon when, along with other youths, he had striven to offer resistance to the invader. The residence of the Siemens family at Lenthe was soon cut short, for an

* Personal Recollections of Werner von Siemens. Translated by W. Coupland. London: Asher & Co.

imaginary offence against the game laws of Hanover, which at this time was under British rule, caused them to seek a new home in Mecklenburg. Werner was the eldest of a family of several children; the care of the elder for the younger children was prescribed as a primary duty, and out of this arose a somewhat amusing incident. It was a rule of the family that if one of the younger children did wrong, the seniors were liable to be punished as well. This bearing somewhat heavily upon Werner, he assumed the right to set the penal law in motion in respect of his juniors, which naturally led to counter-coalitions and violent combats. One day a dispute between Werner and his brother Hans occurred, and as they were carrying self-fabricated cross-bows intended for the destruction of small birds, it was resolved to fight a duel. This was done to some purpose, for Hans discharged his arrow, consisting of a knitting needle for head, with such good aim, that it buried itself in Werner's nose. This small detail of childhood shows how real life was to the Siemens children. After a period of tutorial teaching, Werner was sent to Lubeck Grammar School, and soon afterwards joined an artillery corps of the Prussian Army. This, practically, was the beginning of his technical training, for he was enabled to attend the school of the united artillery and engineers in Berlin. "The three years which, from the autumn of 1835 to the summer of 1838, I spent at the Berlin and Engineering School, I reckon to be the happiest of my life." He was full of enthusiasm for his teachers, among whom were Ohm, Magnus, and Erdmann. It was natural, with his ardent desire for learning, that he should make rapid progress under such able men.

It is particularly interesting to English readers to note the influence of Werner upon his brother William's career. William was at the Lubeck School receiving a commercial training and Werner says:

> That William was to be a business man didn't at all please me. At that time I shared the aversion of Prussian officers to the mercantile class, and also William's somewhat reserved, but intelligent nature, and his clear understanding particularly attracted me. I accordingly begged my parents to let him accompany me to my future garrison town, Magdeburg, that he might attend the highly esteemed school of trade and commerce of that place. The parents consented. . . .
> I had a personal delight in watching his rapid development. . . .
> I also induced him to give up the unsatisfactory lessons in mathematics at the school, and to learn English instead.

Then Werner relates how he met with an accident which impaired his hearing for life, caused by the premature explosion of a chemical compound. We follow him to Wittenberg, whither he was transferred in the autumn of 1840. Here occurred the well known imprisonment for participating in a duel. He was sent to the Citadel of Magdeburg for a term of six months, but contrived to convert his cell into a laboratory, where he continued his experiments in electrolysis. How these researches were rudely broken in upon by a Royal pardon is well known. Then followed a period at the pyrotechnic factory at Spandau, after which he filled a position in the Ordnance Department at Berlin. William Siemens about this time had entered the engineering works of Count Stolberg, and the problem of the precise regulation of steam engines had exercised his thought. He communicated a plan to Werner, who suggested modifications, and from this came the differential governor. Shortly after this William came to England for the purpose of disposing of some of his brother's inventions. He came short of money, but succeeded in selling the plating patent to Elkington for £1,500. During this visit he acquired a strong taste for English life, and soon determined to settle here. Werner approved of the idea, and William came, bringing with him a few inventions of his brother. A small place was rented in "a narrow lane" near the Mansion House for experimental purposes, and William became launched on his career in a strange country and among a strange people. How well this career prospered it is needless to mention here, but it is interesting to know that the whole success of the late Sir William Siemens was due to real ability, to earnest efforts, and to no extraneous circumstances.

But we must return to Berlin, where Werner is troubled with thoughts of his apparent neglect of serious scientific study. He determined to sell his inventions, and devote himself heart and soul to scientific work; he attended lectures at Berlin University at the time when Jacobi, the mathematician, was regularly discoursing. During this period he helped to form the Berlin Physical Society, in which achievement he was associated with Du Bois-Reymond, Helmholtz, Clausius, Wiedemann, and Knoblauch. He is not niggardly in recognising the help he gained from this association, for he says:—

> Intercourse and co-operation with these young men, distinguished by talent and earnest endeavour, strengthened my preference for scientific study and labours, and kindled in me the determination to be in future the votary of strict science alone.

How much applied science would have lost, if Werner had stuck to this resolution, it is impossible to say. But, after a time, there is a distinct wavering from the ideal, and he is soon compelled to admit that:—

> Circumstances were stronger than my will, and the native impulse never to let acquired knowledge lie idle, but, as far as possible, to make some use of it, led me ever and again back to technology; and so it has been all my life long. My affection has always been given to pure science as such, but my labours and achievements have been for the most part in the domain of applied science.

His experiments in electrical experiments were stimulated by participating in the labours of Leonhardt, who was at this time experimenting on the substitution of electric for optic telegraphy. He soon suggested improvements on the Wheatstone indicator telegraph; the construction of this model "I entrusted to a young mechanician named Halske, with whom I had become acquainted through the Physical Society." An incident is sufficient to reveal a characteristic of Halske, for Werner says:—

> As Halske at first entertained doubts whether my apparatus would act, I myself set up a couple of automatic telegraphs, composed of cigar boxes, tin plate, a few pieces of iron, and some insulated copper wire, which worked with perfect certainty. This unexpected result filled Halske with so much enthusiasm for a design capable of execution, notwithstanding such defective materials, that he gave himself up with the greatest eagerness to the construction of the first apparatus, and even declared himself ready to withdraw from his firm, and in conjunction with me to devote himself entirely to telegraphy.

Then Werner matured the idea of leaving the army and devoting himself to perfecting his new telegraph; but an infringement of discipline nearly caused him to be transferred from Berlin. This would have frustrated some of his domestic plans, and he set to work to discover something which would gain him permission to stay in Berlin. Improvements in gun cotton suggested itself to him, and by assiduous work, he found out a gun cotton which had quite different properties to that hitherto used. This was submitted to the Minister of War and approved of, and the danger of removal from Berlin was averted. Incidentally it is worth giving Werner Siemens's opinion of what constitutes a discoverer.

He had already sent in his report on gun cotton when Prof. Otto discovered anew, and published Siemens's method of preparing serviceable gun cotton. With singular magnanimity, Werner says:

> My earlier action in the matter, and my report to the War Office remained, of course, secret, and Otto therefore must rightly be held the discoverer of serviceable gun cotton, since he was the first to make public the method of its production. It has often been so with me. It appears at first sight hard and unjust that anyone may, by earlier publication, appropriate the honour of a discovery or invention which another, who has worked at it long with ardour and success, would only make known after the most thorough testing. On the other hand it must, however, be admitted that some definite rule must be established in regard to priority, since for science and the world it is not the person, but the thing itself and its publication that is of importance.

Werner Siemens's connection with telegraphy was so important, that we are justified in giving a somewhat lengthy extract, which shows his early efforts in the State telegraph department, and also the founding of the great house of Siemens & Halske.

> . . . . I was able to devote myself with a tranquil mind to telegraphy. I sent Oetzel, the chief of the optical telegraph department, under the immediate direction of the staff, a memoir on the condition of telegraphy and the improvement to be expected therein. In consequence of this I was ordered to place myself at the service of the commission of the staff, which was deliberating on the introduction of electrical instead of optical telegraphs. I succeeded in gaining the confidence of the general and his son-in-law, Prof. Dove, in so high a degree that the commission almost always assented to my proposals and entrusted me with their execution.
> It was then regarded as altogether out of the question that a telegraph wire easy of access, attached to posts, could be really serviceable, since it was imagined the public would destroy it. Accordingly, wherever, on the European continent it was desired to introduce electric telegraphs, experiments were first made with subterranean conductors. The best known were those of Prof. Jacobi, in St. Petersburg: he tried resin, glass tubes, and India-rubber as insu-

lators, but had obtained no permanently satisfactory results. The Berlin Commission likewise had begun such experiments, which, however, just as little yielded a satisfactory durable insulation.

By chance, my brother William, in London, had sent me, as a curiosity, a sample of a substance which had recently appeared in the English market, gutta-percha. The remarkable properties of this material, of becoming plastic in the heated state and when cooled of being a good insulator of electricity, aroused my attention. I covered some pieces of wire with the heated material, and found that they were thoroughly insulated. At my suggestion the commission gave orders for more considerable experiments. . . . .

In the summer of 1847 the first long subterranean wire from Berlin to Grossbeeren was laid by me with such insulated wires. As it stood the test perfectly, the question of the insulation of subterranean wires by the employment of gutta-percha and my press appeared to be now successfully solved. . . . . The resolution to devote myself entirely to the development of telegraphy was now fixed. Accordingly, in the autumn of 1847, I induced the mechanician, J. G. Halske, to whom our common labours had bound me closely, to hand over his business to his partner, and to start a telegraph factory, into which I reserved to myself the right of entry on my discharge. As Halske, just as little as I, had available resources, we had recourse to my cousin, George Siemens, a barrister residing in Berlin, who lent us 6,000 thalers for the erection of a small workshop, on condition of a share in the profits for six years. The workshop was opened on October 12th, 1847, in the back part of a house in the Schöneberger Strasse—where Halske and I also took rooms—and grew rapidly, and without the aid of outside capital, into the world-known establishment of Siemens & Halske, in Berlin, with branches in many of the chief cities of Europe.

(*To be continued.*)

ELECTRO-CHEMICAL EFFECTS ON MAGNETISING IRON.*

BY THOMAS ANDREWS, F.R.SS.L. & E.

Experiments with Magnetic Polar Terminals.

IN course of an earlier part of this research, the author made many preliminary experiments to investigate the possible electro-chemical effect between the polished end discs or alternate polar terminals of straight round steel magnets when immersed as elements in some electrolytes, only the north and south terminal planes of each steel magnet being simultaneously exposed to the action of the electrolyte.

Indications were afforded, under certain conditions, of a tendency on the part of the N. terminal of the magnet to become from some cause electro-positive to the S. terminal plane.

The magnets were placed parallel at some distance apart in an upright position, the lower end of each magnet, exposed in the solution, was covered with black India-rubber tubing, so that the flat polished terminal discs only were exposed to the action of the electrolyte. The bars used for the magnets were of polished steel, 4¼ inches long, $\frac{5}{16}$ths inch diameter, cut adjacently, previous to magnetisation, from a longer bar. A pair of magnets were securely placed in a wooden frame, and the N. and S. terminals of each bar immersed in the solution placed below. A number of experiments were made with the arrangement, and with a galvanometer in circuit, using a pair of new steel magnets each time. In these observations the current appeared to flow from the N. to the S. polar terminal; care was exercised to ensure that the magnets were as near as practicable equally magnetised.

The indications of the apparent tendency of the N. pole to become electro-positive in an electrolyte appeared somewhat singular, and after communicating these preliminary results to Professor G. G. Stokes, and conferring with him thereon, it was decided to make further experiments, and in course of these I have endeavoured to utilise some valuable experimental suggestions which Professor Stokes kindly made.

Professor Stokes suggested that the results noticed in the first set of experiments might probably be accounted for in the following manner, thus: supposing the bars to be equally magnetised permanently, then when the magnet bars were placed in the upright position the magnetism induced in the bars by the earth's magnetic force would in one magnet strengthen, and in the other oppose the permanent magnetism, so that the stronger pole would be the N. one at the bottom. To investigate this possible aspect of the matter, an apparatus was constructed with which to conduct the further investigations. The arrangement consisted of a wooden stand, the thick upper cross-bar of which was hollow and formed a tank sufficiently capacious to hold a suitable quantity of the electrolyte. The ends of two magnetised steel bars were securely inserted from below through the two holes in the bottom, so that the upper terminal discs only of the magnets were exposed to the solution. These holes were very accurately and carefully drilled, and when the bars were forced in, the arrangement was quite fluid-tight, and the greatest care was exercised to ensure that the terminal planes only of the magnets were exposed to the action of the solution. The steel rods were connected with a galvanometer which was introduced into the circuit, and the electrolyte was then poured into the upper receptacle and the readings of the galvanometer noted. A new wooden stand was prepared for each experiment, and a new pair of steel magnets was also employed for each observation. In many experiments the electrolyte was first introduced to the lower ends of the bars, and observations first taken of the relative electro-chemical positions of the N. and S. terminals at the lower end of the magnets. The solution was afterwards removed, the lower bar ends cleaned, and the electrolyte subsequently placed in the upper receptacle. By this means an indication of the relative electro-chemical position of both the upper and lower polar disks of the same pair of steel magnets was afforded.

In course of the investigations it was frequently noticed that an instantaneous fling of the galvanometer occurred on first immersing the bars in the electrolyte, the fling showing the S. polar terminal to be positive at the moment of commencing the experiment; this instantaneous fling of the galvanometer very rapidly subsided, and the subsequent readings showed a continuously steady positive position for the N. pole. It will also be generally noticed that the E.M.F. steadily increased from the commencement of an experiment, when the electrolyte was placed either above or below the magnets, the polar influence appearing gradually and increasingly to affect the action taking place. An examination of the results of the total observations, on the steel magnets, in which the electrolyte (cupric chloride solution) was placed below the magnets, gave an average E.M.F. of 0·014 volt; whereas the observations made with the electrolyte above the magnets yielded an average E.M.F. of 0·011 volt. Further experiments were also confirmatory of this difference in the extent of E.M.F.

The general results seem, therefore, to indicate that the positivity of the upper N. polar terminal was reduced relatively to some extent when the electrolyte was placed above the magnets, and this circumstance may possibly be owing to the action of the upper N. pole having been comparatively weakened by the influence of the earth's magnetism, as suggested by Professor Stokes. This difference, ascertained from the results of such a considerable number of observations, in the extent of the E.M.F., may perhaps thus be accounted for. It will be seen that the united results lead to the tentative conclusion that there was a general tendency, under the conditions of experimentation, on the part of the N. magnetic terminal of the steel magnets, to assume electro-chemically the positive position compared with the S. terminal, when these constituted elements in certain electrolytes. The result was seemingly due to the magnetic poles diversely influencing the action of the solution on the metal; and in the case of the copper salts, the ratio of the electro-deposition of the copper was apparently affected by these magnetic influences.

* Abstract of Paper in the *Proceedings* of the Royal Society.

THE FATAL ELECTRIC LIGHTING ACCIDENT AT BLACKFRIARS.

THE inquiry was resumed on Tuesday afternoon, before Mr. A. C Langham, Deputy Coroner for Southwark, at Guy's Hospital, as to the death of Frederick William Ball, aged 34, who was killed by electricity at the local station of the London Electric Supply Corporation, Limited, Blackfriars Road, on Tuesday, September 12th. It will be remembered that on the night in question a man named Hunt, who worked in the same building as that occupied by the corporation, was called to the works by a lad, and found the deceased lying dead between the two converters and a stool. Another man named Meech was crawling on the floor suffering from terrible burns. A duster was found lying on the terminal of No. 42 transformer, which was connected with the omnibus bar, and the deceased had, it was stated, left the omnibus plug on when it ought to have been off. Had it been off when the dusting was begun it was said that the accident would never have happened. The inquiry had been adjourned from October 16th of last year for the attendance of Meech, who was now present in Court, his left hand and arm being enveloped in surgical bandages. Mr. O. A. Shinner, Government inspector of factories, attended from the Home Office, and Mr. Hurd and Mr. Gilbert appeared respectively on behalf of the widow and the Electric Supply Corporation.

MEECH stated that he was still in the employment of the Electric Supply Corporation. On September 12th he was at the Blackfriars Road station with Ball. It was Ball's duty to turn off the current about 6 o'clock each evening, and to obtain a fresh supply from Deptford. It was then witness's work, after the current had been switched off, to "clean down" the machines. On the night in question he asked Ball, as usual, if it was safe to begin to work, and received a reply in the affirmative. He began to dust down, and on coming to transformer 42 he caught the current between the thumb and finger of the left hand. He was standing on the ground at the time, and fell into the pit in an insensible condition. On recovering consciousness he shook Ball, and, receiving no answer to his questions, he concluded he was dead. He then crawled on his hands and knees to the door.

By the CORONER: He had then been a fortnight in the employment of the corporation, and had only been instructed in his duties by Ball. He quite understood that it was dangerous to go near the transformer when the plug was on.

The CORONER: Can you account for Ball telling you it was safe?

WITNESS: I cannot.

The CORONER: Did you wear boots?

WITNESS: No; but Ball did. We had no gloves on at the time.

A JURYMAN: Did you know the plug was in the transformer?—No.

The CORONER then read over the evidence, and said he felt sure they were all pleased to know that Meech had recovered. He thought they could come to no other conclusion than that Ball's death was due to an accident; but in returning their verdict, he thought the jury might suggest a remedy which might prevent accidents in the

future. He thought that India-rubber gloves might be worn with advantage. He was sorry Major Cardew, of the Board of Trade, had been unable to be present. On the last occasion Major Cardew had suggested to him that when the current was on, the electric light should be fixed over the place where the contact was made—that was, at the uninsulated part of the omnibus bar—so that if the current was on it would be lighted by it, and would be seen by those at work. Major Cardew thought the glass globes ought to be coloured red, so that when the workmen went to dust, they would at once see the light. He thought that was a very practical suggestion.

The jury returned a verdict of "Accidental death," and added: "We are of opinion that had the men been provided with gloves, the danger might have been averted. We also think that the rules and regulations at the station should be printed, and that the second man (Meech) should have been more competent before undertaking the work."

ASSISTED TELEGRAPH COMPANIES.

THE following is a list of telegraph companies which benefit, either directly or indirectly, from subsidies or guarantees paid by the Imperial or Colonial Governments and others. This information is mainly derived from "The Stock Exchange Year Book for 1894":—

THE AFRICAN DIRECT TELEGRAPH COMPANY, LIMITED, has a subsidy for 20 years, from September, 1886, of £19,000 per annum, payable by Her Majesty's Government. The authorised share capital is £300,000, of which £236,000 has been subscribed and paid up by the Eastern Telegraph Company, the Brazilian Submarine Telegraph Company, and the Telegraph Construction and Maintenance Company; the two former companies holding £75,000 each.

THE EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY, LIMITED.—A portion of the debentures of this company are secured upon subsidies amounting to £60,000 per annum, guaranteed for 20 years from 1879 by the English, Cape of Good Hope, Natal, and Portuguese Governments. Another portion of the debentures is secured by first charge on the subsidies, amounting to £28,000 per annum, payable by Her Majesty's Government for a period of 20 years in respect of the recently laid cables connecting Zanzibar with the Islands of Seychelles and Mauritius. Almost the whole of the share capital of this company is held by the Eastern Telegraph Company.

THE EASTERN EXTENSION, AUSTRALASIAN AND CHINA TELEGRAPH COMPANY, LIMITED.—This company receives £32,400 per annum from 1879 to July, 1900, from the Governments of New South Wales, Western Australia, South Australia, Victoria, and Tasmania. Beyond this amount, in consequence of an agreement entered into with the above colonies, this company received for the year ending April 30th last the sum of £21,779, being the half of the reduction in receipts owing to the lowering of the tariff.

THE WEST AFRICAN TELEGRAPH COMPANY, LIMITED, has a 25 years' guarantee of traffic from the Portuguese Government, equivalent to £42,000 per annum, while the French Government gives a subsidy for 23 years of £3,000 per annum for each of four stations; diminishing for any station after its receipts exceed £5,000 per annum and ceasing when the receipts reach £8,000 per annum. A large amount of the share capital is held by the Eastern and South African Telegraph Company, of which, as above pointed out, almost the whole of the share capital is held by the Eastern Telegraph Company.

THE HALIFAX AND BERMUDAS CABLE COMPANY has a subsidy of £8,100 per year for 20 years from the opening of the cable for traffic in July, 1890.

THE NEW CALEDONIA-QUEENSLAND CABLE has a guaranteed subsidy of £12,000 per annum from the Governments of France, Queensland, and New South Wales.

Added together, the above subsidies or guarantees come to a total of £235,279 per annum, which, it will be admitted, is a handsome contribution towards the revenues of the above-mentioned companies.

CORRESPONDENCE.

Electrolytic Purification of Sewage.

The letter of Mr. Webster, *re* Hermite's electrolytic process, is tantamount to a claim by him to the exclusive and absolute monopoly of the disinfection of sewage by electrolysis.

If, however, I combine the decomposition and purification of sewage by the electric current with the deodorising action of ozone, how can Mr. Webster prevent me from doing it?

He also says, "I noticed in your last week's edition that a company had been formed for making chlorine compounds, &c., from solutions of chlorides, &c.; as far as I can judge this is a replica of one of my patents, in which I used a porous diaphragm to separate the products."

Does Mr. Webster really believe that this is a replica of one of his patents? I am sorry to say that it is a delusion, as there have been electricians who, many years before him, used a porous diaphragm to separate the products of the electrolytic decomposition of chlorides, &c.

E. Andreoli.

Professors and Consulting Engineers.

The letter which appears in the last number of the ELECTRICAL REVIEW, signed "A.I.E.E.," clearly shows that the young writer has been issued from the *shoot* of a "mill" that yields only *chaff!*

Andrew Jamieson.

January 13th, 1894.

Explosions in Electric Light Culverts.

In your leading article on the above subject in last week's issue, you say that the infiltration theory is quite inadequate to account for the presence of an explosive mixture in street junction boxes.

In one case within my own knowledge there occurred considerable accumulations of coal gas in the street boxes, of a system of distribution mains, consisting of insulated cable drawn into cast-iron pipes.

The mains were completed some considerable time before the works were ready, and on raising the covers of the boxes, in order to test the different sections before commencing to supply, the odour of coal gas was so strong at three of the boxes, that the covers had to be left off for some time before it was possible to get into the chambers.

I cannot say whether the mixture was actually explosive, as no samples of the gas were taken, nor was the "usual" method of applying a naked light resorted to, but the smell of gas was very powerful.

Means were taken to provide ventilation by connecting the main culvert at the lighting station with the bottom of the chimney, and also by fixing ventilating pipes to some of the boxes. The gas company were also communicated with, and a search was made for leaks in the gas pipes in the vicinity of those boxes which were the worst as to smell of gas, and these precautions coupled, no doubt, with the current of air which must be induced in the pipes by the rise in temperature during the period of full load, have apparently been successful in removing the danger, as there has been no explosion.

David Urquhart.

17, Victoria Street, S.W.

Fuel Economy.

Referring to your article of 5th inst., respecting my letter published in your issue of December 22nd last, on the subject of fuel economy, will you be so good as to note, in reference to the Basingstoke fuel, that I did not state that the refuse was "riddled" free of pots and pans, but that they were "removed?" As a matter of fact, the largest of them only are picked out by hand, and the refuse, as it lies in the boiler house, presents the appearance of being in its crude state. It consists of cabbage leaves, potato peelings, bottle straws, broken crockery, small glass bottles, cinders, and the other miscellaneous articles which find their way into the dust-bins.

With respect to clinker, about 9 cwts. is removed from the furnaces during nine hours' work, *i.e.*, about 35 per cent. to 40 per cent. of the total weight of fuel put in.

William Boby.

Action for Wrongful Dismissal.—We understand that the action brought by Mr. Julius William Hintze, who was electrician to the West India and Panama Telegraph Company, having sole control of their submarine cables in the West Indies, to recover damages for wrongful dismissal, has resulted in an order being made by consent against the defendant company for £100 damages and costs. The plaintiff's solicitor was Mr. Joseph Davis, of 21, Liverpool Street, E.C. The defendant company were represented by Messrs. Bircham & Co., solicitors, of Winchester House, Old Broad Street.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's).—The above directory is now in the press, and all orders for the 1894 issue, should be forwarded at once to H. Alabaster, Gatehouse and Co., 22, Paternoster Row, London.

The State of Trade during 1893, and Prospects for the New Year (*continued from page* 39).

Clarke, Chapman & Co., Limited, of Gateshead-on-Tyne, have carried out a large number of electric light installations on land and on ship-board, which are too numerous to give in any detail but prominent amongst which are the *Yoshino*, war vessel belonging to the Japanese Government and built at Sir W. G. Armstrong, Mitchell and Co's., Limited, Elswick Yard; the North German Lloyd Company's passenger steamers the *Mark*, *Pfalz*, and *Roland*, each fitted with two generating plants with compound engines; three large battle vessels built at Messrs. Furness, Withy's, West Hartlepool; the ss. *Trinidad* and ss. *Pembrokeshire*, of the Quebec Steam Shipping Company; the two vessels, the *Perthire* and *Buteshire*, built at Messrs. Hawthorne, Leslie's, and belonging to Messrs. Turnbull, Martin & Co.; the ss. *Midnight Sun*; several of the boats of the "Prince" line of steamers, and a large number of oil vessels. Among the land installations might be mentioned the Holme Head Dye Works, Carlisle; the Mercantile Dry Dock, Jarrow; the Wallsend Slipway and Engineering Company, &c. They have also supplied electric pumping plant for mines, and a large amount of search light plant for use in the Suez Canal passage, besides other work. The firm have several ships and other work in hand at present.

Lithanode and General Electric Company, Limited, report an exceedingly busy and progressive year. A great number of portable hand-lamps and other small batteries have been supplied. During the year many improvements have been made in the manufacture of lithanode, and it is thought that little can be done in the way of further improvements. The Lithanode Company report business done with most of the electrical firms of good standing in this country, and many substantial orders from the Continent, America, Australia, and South Africa have been successfully carried through. The company have given much attention to batteries for vehicle lighting, and as an example of the successful illumination of vehicles may be cited the new Great Northern Railway omnibuses, which are said to be the most perfectly lighted vehicles to be seen in London. The whole of the lamps in these omnibuses are worked by lithanode batteries. There seems to be some misapprehension abroad with reference to the capabilities of lithanode accumulators, and it is generally supposed that this active material is only useful for cells of small dimensions and low capacity. This is an entire fallacy, for within the last 12 months many hundreds of tons of large lithanode cells have been sold; among these being a 220-cell battery for central station work. Each cell in this particular battery has a useful current capacity of 650 ampère-hours, and is capable of being discharged up to as high a rate as 300 ampères. A large business has been done in the replacement of other makers' positive plates by the company's improved lithanode plates. The result of this combination has, in all cases, proved entirely satisfactory, and many hundreds of cells of various capacities have been treated in this way. The company have carried out during the past year several important electric light installations. The Gresley Brewery, at Gresley, near Burton-on-Trent, has been entirely lighted by this company. The company are now engaged in putting down a large and complete electric lighting plant in the Cheltenham Brewery, the adjoining Fleece Hotel, and a moderate-sized private house. In addition to the work already enumerated, the company have carried out extensive alterations to the main switchboard of the General Post Office, London, and have also carried out some work in other important Government establishments. Electrical lighting for stage purposes has occupied a somewhat important position in the company's operations, and many electrical novelties have been carried out at the Alhambra Theatre, the Comedy Theatre, at the Crystal Palace, and at the New Olympic. The portable batteries now in use at Drury Lane Theatre have been supplied by this company, and, perhaps, the most extensive temporary installation of the electric light on the stage is now being carried through by this company for Mr. Oscar Barrett at the Lyceum Theatre. For scientific and testing purposes, lithanode batteries have been very successful, and many large testing batteries have been installed in several of the most important laboratories in this country. Among these may be cited a 100-cell 12 ampère-hour battery for Lord Kelvin's laboratory in Glasgow, and similar testing batteries have been supplied to the University College Laboratory, London; Board of Trade Electrical Department, London; the Brush Electrical Engineering Company, Loughborough; and the Brighton Corporation electricity works.

Messrs. Lowcock, Hill & Co., report that although they have only been established since the commencement of 1893, they have met with considerable success. The staff has been fully occupied upon the following, among other installations:—Messrs. Dobson and Barlow, Limited, works, Bolton; J. G. Brook, Esq., residence, Edgerton, Huddersfield (engine, dynamo, and Epstein accumulators); Messrs. Thomas Brook & Sons, warehouse, Buxton Road, Huddersfield; Messrs. T. Wrigley & Sons, warehouse, Buxton Road, Huddersfield; the Falcon Cliff Pleasure Grounds and Dancing Palace, Douglas; the South Pier, Blackpool (Brockie-Pell arc lamp installation); Messrs. J. Bacon & Co., two shops, St. Ann's Street, Manchester; Messrs. Satterfield & Co., Limited, three shops, St. Ann's Square, Manchester; also a large number of other installations in Huddersfield, Manchester, Blackpool, &c.

(*To be continued.*)

Folkestone and Electric Lighting.—The Corporation last week held a very lengthy meeting, discussing the electric lighting question. From the seven-column report published by a local paper it would appear that the greater part of the time was wasted in what is known by modernists as "obstruction." The gist of the report presented by the Electric Lighting Committee was as follows:—"The services of a consulting and electrical engineer, Mr. Mark Parker, of Rochester, were raised for the purpose of advising the committee. Mr. Parker has presented a report, which describes the various systems of electric lighting now in operation, their respective advantages and disadvantages, and is accompanied by diagrams. In addition to this report three of the members of the committee paid visits of inspection to the following places where installations have been established, viz., North Eastern Railway at York, House-to-House (West Brompton), Leeds, Hastings, and more especially to the installation of the City of London Electrical Supply. The committee is of opinion that there already exists a sufficient demand for the supply to warrant the erection of an electrical installation. Enquiries have been already made by several establishments in the town as to the cost of erecting private installations, and arrangements have also been already made for its actual use in the mansions now being erected on the West Leas. As to the powers for carrying out the necessary works, the committee is of opinion that it should undoubtedly be carried out by the Corporation, and that it would be extremely prejudicial to the best interests of Folkestone if the Corporation were not to do so. The committee advise the introduction of electric light both for public and private purposes. The committee recommend the adoption of the high-tension alternating current transforming sub-station system as best suited to the circumstances of Folkestone. The committee advise that the first section shall be confined to the following streets:—Sandgate Road, from Town Hall to Earl's Avenue; Church Street, from Town Hall to Priory Gardens; The Leas, from Priory Gardens to Earl's Avenue; Guildhall Street, from Town Hall to Shellons Street; Rendezvous Street, from Town Hall to Tontine Street; Tontine and Harbour Streets and Marine Parade to Victoria Pier; the cross streets from the Town Hall, between the Sandgate Road and the Leas; Castle Hill Avenue to Shorncliffe Road. The total capacity of the plant, the committee advises, should be an installation of 490 kilowatts, 280 of which would be in constant action, and the remaining 210 would form a reserve to meet demands for further supply within the borough as occasion arises for the electric supply. The capital sum for this plant would amount to £35,000. Two schemes for public lighting have been under the consideration of the committee: No. 1, proposes to use 80 arc lights of 2,000 C.P.; No. 2, proposes a combination of 80 arc lights and 160 glow lamps of 25 C.P. each. This system has the advantage over No. 1 as regards cost, being about £200 less per annum than would be the cost of No. 1, but, taking all the points into consideration your committee recommend for adoption, the system No. 1. The illuminating power of system No. 1 would be twelve times that at present received from gas, and would cost about £300 more than at present. The illuminating power of system No. 2 would be seven times that at present derived from gas, and would cost about £120 more than at present, but the enormously increased illuminating power is a full compensation for this extra cost. Summary of the financial position under this report, and of the estimated income and expenditure in respect of the area designated in this report and the plan:—

Estimated total cost of the generating plant, as per estimate No. 4		£35,009
Estimated income:—		
Public lighting	£1,536	
Private lighting	£8,121	
Total		£9,657
Estimate of working expenses, including coal and other material, salaries and wages, rates and taxes, and incidental expenses ...	£6,192	
Interest and sinking fund, say 5½ per cent. on the cost of £35,000	£1,925	
		£8,117
Credit balance, per annum		£1,540

The report recommends that Mr. Parker be retained as engineer for carrying out the erection, &c., work; that a site be selected, and the station erected, and that application be made to the Local Government Board for power to borrow £35,000 for electric lighting purposes. It was ultimately decided to adjourn further discussion on the matter for three weeks, enquiries to be made in the meantime for the purpose of ascertaining the probable number of consumers of the current.

Hotel Electric Lighting.—The North Stafford Hotel at Stoke-upon-Trent is being fitted up with the electric light, though the gas fittings will be retained for use when occasion arises. There are at present 130 lights on, and the plant is sufficient to produce as many more. So far nearly all the principal part of the hotel is lighted by electricity, such as the coffee room, the commercial room, the reading room, the large hall and the corridors, as well as the principal bed rooms, and it is intended eventually to light the kitchens and cellars, in fact, the whole hotel, by incandescent lamps. The generating plant is situated at the back of the hotel. There is one 12-unit compound-wound dynamo coupled to a direct high-speed engine, manufactured by Messrs. Bumstead & Chandler, of Hednesford. The dynamo was made by the Electric Construction Company. In addition to this there is a small vertical engine, manufactured by Messrs. Marshall, of Gainsboro'. This latter engine, in addition to a 5-unit dynamo, supplied by the Gülcher Company, would drive the laundry machinery. The whole of the installation has been erected by Mr. H. A. Lewis, under the superintendence of Mr. J. Neale, telegraph superintendent of the North Staffordshire Railway. Only incandescent lamps are being used.

English-Made Carbons for Electric Lighting.—It is a matter for regret that all the carbons used in England for arc lighting have hitherto been imported from abroad. The best quality which must be used to attain the best results in this system of lighting come from the continent, while the inferior quality used with much less satisfactory results are an American product. The recent success of the arc light as a high class illuminant has only been attained by the use of the superior continental carbons, a cored positive and a solid negative with a continuous current being used, and both rods cored with the alternating current. Unfortunately, solid positive carbons, often of poor quality, are still used to a large extent, and it is in these cases that the unsatisfactory burning of the lamps leads many to think still that the *arc light* is necessarily at times a *dark light*, and always an unsteady light. Under the title of the English Electric Carbon Company, Limited, a company has been formed to enter commercially into the manufacture of electric light carbons. The chairman of the company is Mr. John H. Darby, the managing director of the Brymbo Steel Company, Limited, and amongst the directors are Sir H. B. Robertson and Mr. J. C. Edwards, of Ruabon. The secretary and manager is Mr. T. Graham Littleboy, an electrical engineer whose connection with electric lighting will enable him to appreciate the necessities of carbon consumers. The factory has been erected at Brymbo, in North Wales, on the most modern lines, equipped with special machinery and appliances, and is now in full operation. The company have secured the rights to all the trade secrets and methods of manufacture of one of the best carbon makers on the continent. A laboratory and testing room are provided, and the utmost care is taken in the selection and treatment of materials, and the testing of the carbons. Customers may therefore be confident that the good quality of the carbons produced will be regularly maintained. British workmen only are employed, no foreigners at all being in the works. At present only the very best quality carbons are manufactured, and an exhaustive series of tests of these carbons in comparison with the best continental brands, by experts who are very well known, show the company that they have very good reason to be satisfied with the quality of their carbons, which, in one set of tests, were reported as burning "the best." As a consequence they may well be sanguine of securing the orders for carbons which have hitherto gone abroad. "Phœbus" is the registered trade mark of the company, and under this name the carbons are being placed on the market. It is to be hoped that electrical engineers and consumers of carbon will give the endeavour to start this industry in England, on a practical scale, every encouragement and assistance, that it may no more be said that all our carbons come from abroad.

Manchester Edison-Swan Company's Showrooms.—We have made a call of inspection at the showrooms which the Manchester Edison-Swan Company, well known in that city in connection with electric lighting, have, with commendable enterprise, recently built at Victoria Bridge, opposite to the Manchester Cathedral, and on the approach to the London and North Western Company's exchange station. To the passer by only one of the showrooms is visible, and the impression given is that this is the full extent of the premises, but on entering, one is made acquainted with the fact that there are a large number of well appointed rooms under the street-ways, which are pleasantly and elegantly fitted with electric light. Besides the ordinary showrooms, the company have fitted up a complete suite of model rooms, elegantly furnished and arranged with every variety of style of electric light fitting. The object of this being that their clients may see the actual effect the fittings they are selecting will have in private rooms. A special feature is made of electroliers of cut crystal glass and gilt metal work, most tastefully arranged, a combination which we must say seems perfectly suited to show the electric light to full advantage. Among a number of beautiful designs in this style, the general lines of which followed the curves taken by water falling from a fountain, the sparkling crystal lending itself very happily to this effect. Besides the drawing, dining-rooms, &c., there is a large and handsome billiard room with a new arrangement for lighting the table, which is a distinct improvement on the old style. Those visitors who take an interest in the engineering part of electric lighting are given an opportunity of examining the generating plant which produces the large amount of current needed for the different showrooms, both gas and steam power being employed, so that gentlemen who think of having the light installed in their country houses can see both systems at work and judge for themselves which would be the more suitable for their purpose. Taken altogether, the show is a very fine one which we do not think is excelled, even in London, certainly not in the North of England; and anyone near Manchester thinking of fitting up their house with the electric light should pay a visit to these showrooms before doing so, as they would then have every opportunity of seeing a very large and pleasing variety of fittings of every possible kind. A visit to these rooms will amply repay one, as the arrangement and extent of the rooms is so very unexpected.

Keighley and the Electric Light.—The Gas Committee of the Corporation have lately been pursuing enquiries into the electric lighting system in operation at several places. On Tuesday last the members, accompanied by the Mayor, visited the House-to-House Company's electric lighting station at Leeds, and the Bradford Corporation's electric lighting station. Arrangements have also been made for visiting Morecambe and other places.

Electric Lighting at Cardiff.—The new buildings of the South Wales Institute of Engineers, just opened, are provided with a complete electric lighting installation by Messrs. Verity. It is intended to have the electric supply from the Cardiff Corporation system when it is complete and in working order, but at present it is obtained from Cardiff Castle, through the kindness of the Marquis of Bute.

Electro-Tanning.—In one of our former issues we mentioned that Mr. L. A. Groth, of 3, Tokenhouse Buildings, E.C., had removed to Orbe, near Lausanne, to establish his system of tanning, in Mr. Rod's tannery there. To-day we are in a position to mention that the place intended for the new tannery is being entirely obtained by blasting away the rocks facing the river Orbe, and this gigantic work was commenced in July last. The first part of the buildings is estimated to be finished at the end of this month, when the tanning will commence with 300 hides per week, whilst the whole tannery, when finished, is estimated for an output of 1,000 hides per week, principally for sale—belting and harness leather. The necessary machinery for finishing the tanned hides into the various kinds of leather have already been ordered, of the very best and modern construction, from England; so no expense has been spared in order to make this Groth's first tannery on a large commercial scale in Switzerland to be one of the finest ever constructed. The motive power required for Groth's machines, as well as for the finishing one, is obtained from a waterfall of about 3,000 horse-power, situated 3 kilometers distant, where two turbines, each of 300 H.P., have been erected; acting upon dynamos from which the power is electrically transmitted into the town Orbe, partly for lighting same (which commenced on the 1st inst., to the entire satisfaction of the inhabitants), and partly to be used as motive power in the large flour mill and the new tannery, both belonging to Mr. Rod. The electrical tramway from Orbe to Chavarnay railway station, on the Jara-Simplon line, obtains also the motive power in similar way from the said waterfall. The quality of Groth's electrically tanned leather continues to remain very superior, and, what is of the most interest to our readers, the Groth's belting is above the average strength of good leather belting, as proved, several times, by Prof. Unwin's tests, his last one, dated October 26th, 1893, being as follows:—"Marked: leather tanned in 5 weeks by Groth's system, Orbe, Switzerland, October 20th, 1893, Jules Rod.—Dimensions: 3·85 inches wide by 0·2 inch thick and 16 inches long. Maximum load, 1·795 tons. Breaking stress, 2·3 tons per square inch of section, or 1,044 lbs. per inch of width; it stretched permanently 6 per cent. in 10 inches. The leather is rather above the average strength of good leather belting."

Blackpool Electrical Tramways and Electric Lighting.—The following minutes of the Electric Lighting and Tramways Committee came up before the Town Council some days ago for confirmation:—December 6th, 1893: Resolved: That from Saturday next, the 9th inst., and until further directions, the carriages on the Blackpool Corporation Tramways be drawn by horses; that the chairman (Councillor Pearson) and the tramway traffic manager (Mr. John Lancaster) be authorised to arrange with Mr. James Lucas for the horse traction required for the Blackpool Corporation Tramways; that the borough electrical engineer be desired to remove the electrical machines from the tramway carriages, and to cover up and protect the electrical machinery belonging to the tramways until further directions, and that (except as regards the running of tramway carriages) he be also desired to take charge of all electrical questions affecting this committee's department; that Mr. Thomas Parker, electrical engineer, be instructed to inspect the Blackpool Corporation tramways and plant, and report thereon to the corporation; that the town clerk be desired to enquire from Mr. M. Holroyd Smith, electrical engineer, the amount of his fee for an inspection of the Blackpool Corporation Tramways and plant, and for a report thereon. December 22nd, 1893: Resolved: That Mr. M. Holroyd Smith, electrical engineer, be retained to make an examination of the tramway route and tramway plant upon the terms named in his letter of December 7th, 1893; that Mr. R. Hammond, electrical engineer, be desired to report and advise the corporation upon any extensions required in connection with the Blackpool Corporation electric light installation.

Proposed Coventry Electric Tramways.—Mr. W. S. Graff Baker is transferring his interest in the Coventry and District Tramways to a company called "The Coventry Electric Tramways, Limited." To this transference the General Works Committee on behalf of the Coventry City Council, at first objected, wishing to be satisfied that the new company would be competent to carry out the obligations to which Mr. Graff Baker was committed. The Town Clerk and the City Surveyor have had an interview at the Board of Trade offices with Mr. Graff Baker and his solicitor. The outcome of the negotiations is that subject to certain conditions the opposition is withdrawn. In the equitable agreement between the Corporation and Mr. Graff Baker, dated April 17th, 1893, it is provided, says the *Coventry Herald*, amongst other things, that the Corporation should not before the expiration of 16 years from the date of the agreement exercise their statutory powers of compulsory purchase, except by paying to Mr. Baker, or his assigns, a sum equal to the amount of the purchase money and cost of equipment, less 5 per cent. for depreciation, together with a certain sum, not exceeding £600, representing the loss, if any, incurred in working the tramways between the date of the purchase by Mr. Graff Baker and the date of the agreement. It is on the understanding that Mr. Baker and the new company enter into an agreement that the loss on working prior to the agreement of April last, shall not be included in the amount stipulated as purchase money to be paid by the Corporation, but that it shall take account only of money actually expended on the tramways and their equipment prior to their transfer to the new company.

Correction.—Messrs. Johnson & Phillips write us, pointing out that in our report of the state of trade during 1893, last week, we stated that the Brush Company supplied the whole of the electrical plant at the Earl's Court Exhibition. As this statement might possibly lead our readers to suppose that the arc lamps were included in the plant, we are asked to say that both inside the building and in the gardens the standard "Brockie-Pell" arc lamp was used throughout.

Heysham and the Electric Light.—Recently a meeting of ratepayers within that portion of the parish of Heysham called "Sandylands," and adjoining to the west end of Morecambe, was held to receive the report of the recently appointed inspectors for the lighting district recently formed under the Lighting Act. Tenders from the Morecambe Gas and Electric Light Companies for the lighting of the promenade and highway from the Battery Inn to Cross Cop were read and considered, after which it was unanimously resolved to adopt a scheme of electric lighting, the Morecambe Electric Light Company undertaking to fix and supply 25 16-candle-power incandescent lamps during eight months of the year, and in June, July, August, and September substitute for the proposed ten lights on the promenade an equal number of 500-candle-power arc lamps. For this their charge would be £49 per year; but as this would not cover the cost of installation, they stipulated that the contract be for three years, and that they have the right to supply for private lighting and motive power within the lighting area. The total cost for gas lighting, including interest on outlay, and providing for lighting, extinguishing, and repairing lamps, was estimated at £95 per year. The inspectors were authorised to make a call upon the local authorities for £50 for the current year's expenses. It is expected that the installation will be completed in about eight or ten weeks' time.

Railway Station Lighting.—The Stoke station of the North Staffordshire Railway Company has been lighted with the electric light. The arrangements were placed in the hands of Mr. J. Neale, telegraph superintendent, and his staff. The directors decided that the Gulcher Electric Light and Power Company's tender should be accepted, and that company has completed the work, but under the direct superintendence of Mr. Neale. The station is lighted by 16 8-ampère Brockie-Pell arc lamps, each giving 1,000 C.P. The goods yard is lighted with four 10-ampère Brockie-Pell arc lamps, each giving 2,000 C.P., and with four 15-ampère Brockie-Pell arc lamps, each giving 3,000 C.P. light. This plant is driven by a Davey-Paxman 40 horse-power economic boiler, and with two Bumstead and Chandler's double-crank compound high-speed engines, working at 120 lbs. pressure, and coupled direct to two Gulcher dynamos, each 20 units, and capable of lighting up part of the offices and waiting-rooms as the scheme progresses.

In re Aluminium Company, Limited.—This was a petition for reduction of capital, which came before Mr. Justice Wright, sitting as an additional judge of the Chancery Division, last week. The case came on before the Christmas vacation, but his Lordship did not then think the evidence sufficient. Mr. Buckley, Q.C. (with whom was Mr. W. F. Hamilton), said that certain newspapers had published reports from which the directors thought it might be supposed that his Lordship had meant to reflect on them. The proposed reduction became necessary, because what originally cost 60s. a pound to produce, could now, by modern methods, be produced at a much less cost. The reason for the proposed reduction had been brought to the knowledge of the directors. Mr. Justice Wright, in making the order asked for, said he had never doubted the *bonâ fides* of the directors, and had not in any way meant to reflect on their conduct. His Lordship could not act without sufficient evidence, and had only required further evidence to be produced.

Dover Lighting.—The directors of the Dover Electricity Supply Company, being anxious to hold an electric lighting exhibition in the Connaught Hall and the old Town Hall at the end of this month or the beginning of next, resolved to ask the Town Council to instruct them to lay on the wires permanently in these buildings. Of course, the company did not profess to be absolutely asking for the contract, but, feeling very considerate, they thought fixing the wires up temporarily might cut or damage the walls, and thinking that damaging the Council's property once was better than doing it twice, they wanted to fit it up permanently. The Town Council discussed the matter and decided to allow the company to do as they desired, although the money for the work will not be forthcoming until the electric light is formally adopted in the Halls by the Council. The wiring for the exhibition will therefore, in the end, cost the company nothing, as, being done permanently, it will be paid for by the Council. The directors have a good eye for business.

The Electric Light in the Hull Theatre Royal.—At the Hull County Court last week, an action was opened for the recovery of £38 10s. 6d. by Messrs. Royce & Co., of Manchester, electrical engineers, the defendant being Mr. Alfred Cuthbert, lessee of the Theatre Royal, Hull. The latter had entered a counter-action, his claim against Messrs. Royce being £50. It appears that Messrs. Royce put an installation of the electric light in the Theatre Royal, in December, 1892, Mr. Claremont, of the plaintiffs' company, superintending the work. The light was sufficiently completed for illumination on Boxing Day of that year, and it was turned on. On March 9th in last year the first instalment of £100 was paid; and a further sum of £50 on August 25th following. The third instalment was due on October 1st, and the action was brought to recover this sum with extras. Mr. Claremont said that 250 more candle-power was supplied than contracted for, equal in value to £25. Judgment was deferred.

Dorchester Electric Lighting.—At a recent meeting of the Town Council the report was received of Mr. Newton, electrical engineer, of Taunton, who had been commissioned to prepare a scheme for the installation of the electric light for the public lighting of the town. It was stated that the capital outlay would be about £6,000, and the annual expenses about £1,300. Mr. Newton proposed to utilise to some extent water power in the borough for driving the dynamos. The expense of the scheme was regarded as prohibitive, and the council unanimously decided that it was not at present advisable to proceed with the scheme.

Robey & Co., Limited.—As we announced in a recent issue, owing to stated circumstances, the business has been turned into a limited liability company. Subscriptions are now invited for £125,000 4½ per cent. first mortgage debentures. These debentures, as well as commanding the first preference as regards the freehold works, also form a floating charge on all the other property of the company. The authorised capital of the company is £300,000, of which £272,000 has been subscribed and fully paid. The management of the company will remain unchanged. Stock-in-trade, plant, book debts, freehold works, &c., have been valued at £392,889, and, unlike many concerns that are heard of from time to time and offered to the public for subscription, nothing has been included in this sum for goodwill.

Portsmouth Electric Lighting.—At last week's meeting of the council, the electric light committee submitted certificates from the engineers (Messrs. Waller & Manville) for payment of £300 on account to the contractor for buildings, £3,700 to the contractors for boilers, engines, and electrical plant, and £1,000 to the contractors for conduits, &c. They also reported that the libraries and museum committee wished to have a supply of electricity for lighting purposes, and as motive power at the proposed technical school, and had agreed to contribute £50 towards the cost, but, as the total cost would be £94, they asked for authority to spend the difference. They also asked for authority to supply the branch library at Southsea at an estimated cost of £25. This was agreed to.

Newington Baths and Electric Lighting. — The Commissioners of Public Baths and Wash-houses for Newington have set aside £500 for electric lighting, but at a Local Government Board inquiry, a fortnight ago, were unable to satisfy the inspector, Mr. Thomas Codrington, M.I.C.E., that the details had been properly worked out. Last Friday, at the adjourned inquiry, Mr. Henry Ward, L.C.C., and Mr. Shoolbred, M.I.C.E., gave expert evidence that the arrangements were adequate and economical. There is a strong opposition to the baths in the parish on the ground of expense, and the provision of electric lighting is cited as one of the extravagant parts of the scheme.

Manchester Ship Canal.—The Unbreakable Pulley and Mill Gearing Company, Limited, claim that they were the first firm to send any engineering material over the complete waterway of the canal. Goods were despatched to London and Glasgow by steamer, and others are to be sent to continental ports. We do not know, however, that there is anything very wonderful in being the first consignors of goods over the Manchester Ship Canal, or that it evidences any exceptionally enterprising business spirit; but it points to the fact that there is likely to be some competition between railway companies and the shipping companies conveying goods between Manchester and London.

Electric Tramway at Douglas.—Lowcock, Hill & Co., 2, St. James's Square, Manchester, have been granted a concession by the Marine Drive Company, Limited, Douglas, Isle of Man, to lay and equip an electric tramway from Douglas Head to Little Ness and Port Soderick for a period of 10 years. The Marine Drive Company having at the end of that period power to purchase the same. No stipulation is made upon which system this tramway shall be worked, the road is a private one cut along the side of the cliffs with bridges erected over the gallies, and it affords a magnificent view of the cliffs and deep chasms for which the coast is noted.

Electric Lighting at Halifax.—A special meeting of the Halifax Town Council in committee was held last week. The Electric Lighting Committee recommended that a site containing 5,000 square yards at the bottom of Foundry Street be secured for an electric lighting station. The report was adopted, and the architect, Mr. W. H. D. Horsfall, was instructed to obtain tenders for the erection of the station. The Gas Committee had accepted tenders for the supply of electric lighting plant, the total cost being upwards of £15,000, and their recommendation was confirmed.

Electric Cranes at Southampton.—It was reported at Southampton Harbour Board, on Tuesday, that the two electric cranes now being fitted on the town quay were completed, and had stood all tests. These are the first of the kind ever erected in any part of this country, and are an improvement on those now in use at Hamburg. The total cost of the cranes amounts to £2,480, and they will at once be put into working operation. At the same meeting it was unanimously agreed to light the Town Quay and offices with electricity instead of gas, as at present.

Richmond Electric Lighting.—The Electric Lighting Company in their last report to the Town Council stated that the laying of the mains was nearly completed within the compulsory and contract area, there being only some 500 feet more to lay. Two of the large engines were in position, and the dynamos were being erected. All the offices and upstair rooms were nearing completion, and the work of finishing off was being done with all the speed possible with the daily supply of the current.

Cowpen and Electric Lighting.—Cowpen has had the electric light in the public streets for five years, the contract for that period expiring on the 12th of next month. Some of the councillors do not look upon the light as an unmixed blessing, and the board have decided to invite tenders for lighting the district for a term of years by any means of illumination.

"Do You Know It?"—With this title a handy little reference book for literary men and readers generally, has been written by Mr. C. E. Clark. Information on almost every subject of interest is contained therein, and the publication is, on the whole, a very useful one.

Electric Light at Shoe Works.—The electric lighting plant at the Co-operative Wholesale Society's Shoe Works at Heckmondwike was last week brought fully into use for the lighting of the works. The work has been carried out by Messrs. Scott & Mountain, Limited, of Newcastle. There are 550 incandescent lamps of 16 candle-power each. The generating plant is located on the ground floor, and consists of a 30 nominal horse-power compound engine, with one 15-inch and one 10-inch cylinder, with 8-inch stroke, and one compound dynamo.

Elmore's Foreign and Colonial Copper-Depositing Company, Limited.—A petition for winding up the above company by the High Court of Justice was, on 15th inst, presented to the Court by James Stevens, of Rosherville, gentleman, a creditor of the said company; the petition is to be heard before the Court sitting at the Royal Courts of Justice, Strand, on January 24th, 1894; and any creditor or contributory of the said company desirous to support or oppose the making of an order on the said petition, must appear at the time of hearing by himself, or his counsel, for that purpose.

Church Lighting.—In our last issue we stated it was anticipated that St. Jude's Church, Southsea, would be lighted by electricity. At a vestry meeting the other day, it was stated that Mr. Manville, who had inspected the church, recommended the installation of over 135 lamps, many of which will be of 50 C.P. The estimated cost was put at about £300. The matter has, however, been deferred for six months.

Electric Light in the City.—Messrs. E. P. Allam & Co., of 49, Finsbury Pavement, inform us they have recently completed the electric lighting of the extensive offices and sample-rooms of the Mazawattee Tea Company, in Eastcheap, and are now engaged, among other work, in wiring No. 50, Bedford Square, for A. Leveson, Esq.

Radcliffe Electric Lighting.—Mr. F. F. Bennett, M.I.E.E., of the firm of Bennett & Druce, of Preston, has been instructed by the Radcliffe local authorities to draw up a report and estimates, and recommend a system of electric lighting for that district.

Aberdeen Electric Lighting.—The Town Council have resolved that the charges for electric meters should vary from 5s. to 30s. per quarter. It is expected that the meter that will be most commonly used will be the one on which the rate is 7s. 6d. per quarter.

Electric Light at Hull.—An installation of the electric light has just been completed at the Minerva Masonic Lodge. The work has been carried out by Mr. G. F. Wells, of Prospect Street, Hull.

Electric Lighting at Aberdare.—Last week the Aberdare Local Board granted the application for assent to the provisional order sought by Messrs. J. C. Howell & Co., for the lighting of a portion of the town.

Bradford and Destructors.—The Town Council last week had a short conversation regarding the advisability of utilising the destructors for electric lighting purposes, but nothing came of it. It seems that the subject will come up later on in resolution form.

Canongate and Electric Lighting.—The Executive of the Canongate Ward Liberal Committee have unanimously agreed to request the Ward representatives to move in Council for an extension of the electric light from St. Mary Street to Holyrood.

Dinner.—The annual dinner of the employés of Laurence, Scott & Co., Limited, and of the Norwich Electricity Company, Limited, took place at the Shirehall Tavern, Norwich, on Friday evening.

Calendars, Catalogues, &c.—Within the last few days we have received a number of catalogues, price lists, calendars, &c., from various firms, but owing to pressure of space we are compelled to hold notice of them over until next week.

Electric Light in Hyde Park.—The St. George's Vestry have agreed to approve of a draft license of the Commissioners of Her Majesty's Works of Public Buildings, to lay electric cable for lighting the lavatories in Hyde Park, near the Marble Arch.

In re Newington Priddle & Co., Limited.—A compulsory winding-up order was made in this case last week, by Mr. Justice Wright. Mr. H. Terrell, Mr. C. E. E. Jenkins, and Mr. George White appeared as counsel.

Private House Lighting.—Swinton House, the residence of Mr. John McNab, has lately been lighted throughout by electricity. Messrs. Graham & Morton, of Stirling, have carried out the work. There are about 150 lights in all.

Battersea and Electric Lighting.—The result of the Vestry's meeting, to which we referred last week, was the appointment of an electric lighting committee, notwithstanding the desire of several members to delay moving in the matter.

Temporary Electric Lighting.—On the occasion of the Shropshire Hunt Ball on 11th inst. at Shrewsbury, the ballroom was lighted by electricity by Messrs. Lea, Sons & Co., of that town.

Change of Address.—Major-General Webber, C.B., has removed his office from Portland House, Basinghall Street, E.C., to 27, Chancery Lane, London, W.C.

CONTRACTS OPEN AND CLOSED.

OPEN.

Roumania.—February 15th. Erection of the Theatre National. The Mayor of the Commune de Jassy is prepared to contract by public tender for the following works, among others, in connection with the erection of the Theatre National, viz.:—Telegraph and lightning conductor, amounting in value to 2,575.00; Engineering works, 1,140.00; Electric installation; Heating and ventilating appliances, 70,000 00; Appliances and fittings for lighting, 24,432.90. (The sum of money these figures represent is not indicated.) Tenders must be delivered at the Hall of the Mairie on Thursday, February 3rd to 15th, 1894, enclosed in sealed envelopes, marked, "Offres pour la totalité des travaux de construction du Théâtre National de Jassy," or "Offre pour serie (state item) de travaux de construction du Théâtre National de Jassy," according as to whether applicant wishes to compete for the entire work or only one or more items thereof. Tenders, in which the items must be stated separately and quoted at unit prices, should be addressed to the Mairie de la Commune de Jassy. None but contractors or companies able to produce testimonials showing that they have previously carried out public works satisfactorily will be entitled to compete. Such testimonials must be lodged at the Mairie de la Commune de Jassy 15 days previous to the appointed date of adjudication, so as to allow due time for enquiries to be made as to their genuineness. No tender will be considered unless accompanied by a provisional guarantee of 5 per cent. upon the value of the work estimated for. The said guarantee must be in cash or bonds of the Roumanian State, or guaranteed by the State, or else in bonds of the Commune de Jassy. Competitors will be ruled by Art. 40 to 57 of the Roumanian Treasury Act. Particulars may be obtained, and plans, specifications, &c., inspected on any day, holidays excepted, at the office of works of the Commune, or on application to the architects, MM. Fellner et Helmer IX. Bez, Servitengasse, 7, Vienna.

CLOSED.

Great Yarmouth.—For erection of electric lighting central station. Mr. J. W. Cockrill, A.R.I.B.A., A.M.I.C.E., borough surveyor.

M. Barnard (Southtown)	£3,656 0
R. Eastoe	3,346 17
G. T. Flaxman	3,124 10
T. Howes	3,093 0
G. Beckett	2,858 10
Carter & Wright	2,817 0
F. Grimble	2,800 0
G. W. Beech	2,768 10
J. F. W. Bray (accepted)	2,626 0
W. Cork	2,510 0
J. W. Rand (withdrawn)	2,485 0

NOTES.

Bury Electric Lighting.—The schemes and tenders submitted to the electrical engineer (Mr. Wynne) being considered unsuitable, the Town Council has decided not to accept any of them, but have instructed Mr. Wynne and Mr. Cartwright to prepare an entirely new scheme on the continuous current system.

Against High Tension Currents.—A *Daily News* correspondent repeats, in a letter headed, "The Dangers of Electricity," the cry against high tension currents. The accident that has prompted him to write is the one related in our "Notes" columns last week, which caused the death of a horse at Bournemouth. We make the following extract from the letter:—"When it is remembered that 'moisture turns any non-conductor into a conductor,' and that extreme high tension electricity makes non-conductors—like glass and other things—into the best possible conductors, as proved at the Crystal Palace experiments not long ago, what, may I ask, is to prevent similar accidents to that which happened at Bournemouth from occurring in the public thoroughfares of London, under which so many high voltage cables or wires run? and what, under the circumstances, is to prevent the deadly electric currents from being carried into private houses by the innumerable gas and water pipes under the same streets in almost close touch with these underground wires? Edison has pointed out over and over again in the American Press that there is no necessity for these high tension currents, and has warned the public authorities of the great danger incurred by their use, and seeing, as he has so tersely put it, it appears to be only a matter of dividends, or 'the price of copper wire *versus* human life,' that gives any excuse for the use of these 'death-dealing' high currents."

Electric Railways.—If all the electric railways recommended by correspondents of the daily newspapers, both in London and the provinces, were proceeded with, the amount of capital invested in such undertakings would be many times what it figures at present. A Hove inhabitant considers an underground electric railway starting from the Coast Guard station at Hove, with a station at the West Pier, and terminating at the Aquarium, would be a great convenience. But would it pay? That is the question.

Electric Traction at Hartlepool.—We understand that a syndicate has been formed which has purchased the Hartlepool Tramways for the purposes of equipping them with the overhead system. The promoters appeared before the Works Committee of both West Hartlepool and Hartlepool Corporations on Thursday, the 11th inst., and, after having explained their intentions, the Committee decided to report in favour of the proposition to the Council. We hear that the system is to be considerably extended.

Electric Light at Bath.—Reports of failure in connection with the supply of electric current in this town have been so numerous, that one might be led to believe that the installation was conspicuous for its inefficiency, but from information that has reached us from an authentic source, it appears that the real facts have been greatly exaggerated. There is much opposition encountered by the electric lighting company at Bath, gas interests being exceedingly strong. Rumours are from time to time being circulated reflecting discredit upon the company, and these statements are doubtless set about by certain people jealous for the safety of the gas undertaking, and who are naturally more or less antagonistically disposed towards a competitive illuminant which may appear to have a great future before it. The facts in our possession impress us with the belief that common justice is not meted out to the electric lighting company, while the gas undertaking is dealt with in the most lenient manner possible. For instance, failures in connection with the gas lighting have occurred hundreds of times without a single fine being imposed, but for every failure in the electric lighting a fine of 5s. per lamp is stringently enforced. Further, the failure of the latter lamps is attributed, in the majority of cases, to the kicking of the posts by some wantonly-minded members of the public, this stupid act causing the carbons to suddenly drop and become locked, or in frosty weather they snap off at the carbon holders. The City of Bath Electric Lighting and Engineering Company, Limited, send out their men three times in the course of every night to inspect and report on the burning of the lamps, and those giving inefficient light are immediately rectified. But whether a lamp has been extinguished for merely one hour or for the whole of the night, whatever the cause may be, a fine is imposed. The least that could be done would be to give equal fairness to the two concerns; if anything, the younger illuminant should have the preference in regard to leniency. Last week we referred to a breakdown which occurred on the 5th inst. The facts are as follows:—At 6.30 p.m. 20 lamps on the east circuit were reported out. The insulation of the cable had broken down in two places, thus cutting the 20 lamps out of circuit. The severe frost rendered the opening of the ground impossible, and a gang of men were started immediately to run temporary wires to cut out the faults. At 2 a.m. the lights were on again. Only a portion of the town was at any time during the evening in darkness, and there was no interruption whatever in the incandescent lamp service. Figures that are furnished impress us with the opinion that the arc lighting of Bath deserves credit rather than the reverse. Last quarter's run consisted of 105,000 lamp hours, during which time the failures only amounted to 5,120 lamp hours; nevertheless, the company were fined £10 5s. The Corporation inspector, it seems, is very diligent in his duty; in fact, almost exacting; he is constantly testing lamps, machines and mains, to see that they are up to their standard. The hindrances the Bath company have to fight are additional testimony to the fact that the difficulty of electing men for posts on municipal bodies who are absolutely impartial, and will not consider their own personal interests in preference to those of the classes whom they are supposed to serve, is a gigantic one.

Shoreditch Electric Lighting.—The Vestry, last week, resolved to purchase a site for an electric lighting station and dust destructor at £33,500.

Coast Communication.—The last of the difficulties which have so long stood in the way of the completion of the arrangements for the telephonic connection of the Goodwin lightships with the shore are now removed, the Ramsgate Corporation having granted the necessary permission for carrying the wires through to the town post office. The connection will be direct between the North Sand-head lightship and the Ramsgate post office.

Lectures.—The other day, under the auspices of the Consett Science and Art Classes, a course of lectures on "Electricity" was commenced in the National Schools, Consett, by Mr. V. A. Mundella, of the Durham College of Science.

On Saturday last, Mr. H. A. Mavor delivered the sixth of a series of lectures to the students attending the Glasgow and West of Scotland Technical College, Bath Street, Glasgow, on the subject of "Electric Power Transmission."

Mr. James Swinburne is now delivering a course of lectures on "Dynamo and Transformer Construction" to the students of the Electrical Standardizing, Testing and Training Institution.

Obituary.—From the *Times* of Monday last we cull the following concise and interesting obituary notice of Herr Heinrich Hertz, whose name, from its frequent repetition in our columns, is well known to our readers, who will share with us the deepest regret at the irreparable loss sustained by such an early termination to a most successful career:—"From a long obituary notice of the late Prof. Hertz, published in the *Kölnische Zeitung*, the following extracts are taken:—'Acute regret will be awakened in every region of the world where investigators and students of physical science are to be found by the announcement that Heinrich Hertz, the distinguished physicist of Bonn, is no more. Hertz's investigations deal exclusively with the relations between light and electricity. Maxwell had handled the subject theoretically, and already in 1865 had developed his electro-magnetic theory of light, which is of far-reaching consequence. In connection with this enquiry, it now became a question of measuring directly, by means of experiments, the rapidity of the transmission of electric action; for instance, the charging of a Leyden jar or the motion of a magnet. Hertz was able to prove experimentally that electric waves, like light waves, are transverse to the line of motion of the wave, and that they require a specific time for their transmission. Further experiments, in which the primary and secondary conductors were placed in the foci of two concave mirrors, showed that the electric waves followed the ordinary law of reflection. By the interpolation of a conducting screen in the path of the rays an electric separator was produced; the rays were not destroyed, but were reflected. Hertz was able to show the phenomena of refraction by the help of large prisms of asphalte or pitch. His experiments proved that there existed, not only optical waves of electricity of the well-known minuteness of waves of light, but similar ones measuring several metres or even kilometres in length. They proved that electric waves may be generated in connection with light waves—that is to say, in innumerable places where their existence had hitherto been unsuspected. It goes without saying that the experimental proof of the intimate relation between light and electricity, now for the first time presented to us in its entirety, did not fail to win signal fame for its discoverer throughout the length and breadth of the scientific world. From a position of relative obscurity Hertz leaped at a single bound to world-wide celebrity. His call, as the successor of Clausius, to the chair of physical science at Bonn, followed in 1889, an appointment destined, alas, to be but of short duration. Heinrich Hertz was born at Hamburg in 1857. He studied physics at Munich and afterwards at Berlin under Helmholtz. He then took up his abode as a lecturer at Kiel, and two years later was made professor at the Technical College of Karlsruhe, where his world-renowned experiments were instituted.' Prof. Hertz died on New Year's Day. It may be added that in 1890 the Royal Society awarded to him the Rumford medal for his discoveries in connection with electro-magnetic radiation."

Explosions in Main Boxes.—Explosions occurring in the street electric lighting boxes during the early hours of the morning are preferable to those happening during the day, when the great volume of foot and vehicular traffic engages the thoroughfares, though in the former instance there is experienced by the inhabitants of the district a very alarming shock, along with the disagreeable task of rising from one's disturbed slumbers to discover the cause of the alarm. This is the opinion of a *Times* correspondent, who writes complaining of another explosion in the street electric lighting main boxes, which occurred at 5 a.m. on January 12th. This time the vicinity was Endsleigh Gardens, N.W. The writer tells the story of his adventures ascertaining from whence the loud report came, in the following graphic manner:—"At 5 o'clock this morning I and my household were awakened, I may say almost shaken from our beds, by a violent shock. Recovering a little from the alarm, and finding there had been neither a gas nor boiler explosion on the premises, I sought the cause in the street. About 30 paces from my front door is a manhole or trap, used in connection with the St. Pancras electric lighting mains. The heavy lid of this was blown away and lying a foot or two off the orifice, sufficiently indicating the locality and force of the explosion." Fortunately no one was injured, and doubtless the St. Pancras Vestry will make an exhaustive investigation into a matter which is rapidly becoming common to underground conductors of a certain class.

Anglo-American Telegraph Company.—The very friendly and sound criticism to which the Anglo-American Telegraph Company has within the last few months been subjected at the hands of the *Financial Times* certainly impresses one with the belief that there is someone connected with that paper who is *au fait* as regards the ins and outs of the company, for which it holds out hopes of anything but a brilliant future. What with the likelihood of increased competition in rates with the Commercial Cable Company, and that which is of immensely greater importance, *i.e.*, the breaking of two of the principal cables, which, it would appear, are practically irrecoverable, having, now they are 20 years of age, broken in 2,000 fathoms of water, the inevitable loss of business, and the general condition of trade, there is certainly need for grave consideration in regard to future action. The replacement of the two lost cables are estimated to almost entirely sweep out of existence the reserve fund, which has been built up to the sum of £1,000,000. Doubtless the directors are considering, or have considered, seriously whether they can dispense with a fourth cable until better times dawn upon them, and thus only lay one new cable at present. A cable company without a renewal fund would be in a pretty hole, and we really feel with our financial contemporary that the wisest policy the directors and shareholders could adopt would be to give up their dividends for the next year or two. Shareholders can hardly be expected to submit to this without grumbling, but it certainly would appear that such a course would be the safer one in the long run. There will, doubtless, be a stormy meeting in a few weeks' time, but the directors are not responsible for the disasters of cable-breaking and competition, though, probably, shareholders will say some very strong things. The weakness of the company, however, lies in the supineness of the administration, whose ideas have not advanced with the times, and especially in the enormous prices paid for their cables. We dealt with this question prior to the laying of the Commercial Company's cables, and in our issue September 22nd, 1883, we pointed out that the laying of two new cables was perfectly justifiable and a safe investment. We predicted for these new cables a possible dividend of 7½ per cent., with 5 per cent. placed to reserve annually. To appreciate how nearly correct we were, one has only to examine the returns of the Mackay-Bennett or Commercial Cable Company. This company is apparently paying 7 per cent. on a share capital of $7,716,000, or, say £1,500,000, and in its 10 years' existence has practically extinguished a debenture debt of £600,000. Putting to the one side the high prices paid by the Anglo-American Company for their cables and for their repairs, there is still room for an improved financial state by taking a leaf out of the book of management of the Commercial Cable Company.

The "Pall Mall Gazette" Printed by Electricity.—Our esteemed evening contemporary, the *Pall Mall Gazette*, was on Tuesday last printed for the first time by means of electric motors. This is the first and only paper in London that is printed in this way, though for some time the printing machines of some of the provincial dailies have been operated by electricity. The electrical power plant put down for the *Pall Mall Gazette* was supplied and designed by Messrs. Mather & Platt, Limited, under the superintendence of their engineer, Mr. Hardman A. Earle, M.I.E.E. It consists of two 40-horse-power motors of the "Manchester" type, driven off the outside mains of the Charing Cross and Strand Electricity Supply Company's three-wire system.

Government and the Telephone.—Notice of motion has been set down by Mr. Provand, M.P., for next session of Parliament, that a Select Committee be appointed to inquire into and report upon the proposed arrangements between the Post Office and the telephone companies as to the working and all other agreements between the telephone companies; and generally on the future policy of the Post Office with reference to the extension of the telephone service. The *Pall Mall Gazette* understands that although the terms of the agreement between the Post Office and the National Telephone Company have not yet been submitted to Parliament, they have been practically settled, subject to ratification by the department after the House of Commons has had the promised opportunity of discussing them.

The Westinghouse Company and the Niagara Contract.—Mr. L. B. Stillwell, the electrical engineer to the Westinghouse Company, in taking exception to some remarks of the *Electrical Engineer* of New York, says that "the system which has been adopted for the installation at Niagara Falls is simply the Tesla polyphase system as developed by the technical staff of the Westinghouse Electric and Manufacturing Company. It has not been modified in any particular by the engineers of the Cataract Construction Company or of the Niagara Falls Power Company. It is fully described in publications of this company, and was demonstrated on a large scale by one of our exhibits in the Electricity Building at the recent Columbian Exposition in Chicago. Prof. Forbes's views, as stated in his paper, are naturally in accord with ours upon many points. In others, his paper fails to fully state the facts as we see them, and, in others still, we think his views are incorrect. We cannot, therefore, in justice to our company, consent to the assumption that his paper be accepted as a 'fair representation' of our views. Some of the technical journals have apparently received the impression that the generator described in Prof. Forbes's paper under the heading, 'General Description of a 5,000 H.P. Alternator' is that which has been adopted by the Cataract Construction Company. This is not the case. The drawings and specifications of the generator, which Prof. Forbes describes were laid before us in August last, and were fully explained by Dr. Coleman Sellers and Prof. Forbes. After careful consideration, we accepted the general mechanical features of the construction proposed as excellent, but, in the opinion of our electricians and engineers, the electrical features—the method of winding, the insulation, &c.—were impracticable, and realising that we could not undertake the construction of such a machine with credit to our company, we declined to submit proposals. We were thereupon requested by the officers of the Cataract Construction Company to submit our own plans and specifications and this was done early in August. We followed closely the mechanical features approved by Dr. Sellers, but the electrical features are wholly our own. These plans were accepted by the Cataract Construction Company, and are those under which the generators for Niagara are now being constructed. . . . . The premises and the reasoning which guided the engineers of the Westinghouse Electric and Manufacturing Company in the development of the Tesla polyphase system, as it will be used at Niagara, differ widely in some respects from those which are set forth in the paper to which your editorial refers. We trust that you will give to this explanation suitable prominence, as we are unwilling, for the reasons stated, to have Prof. Forbes's paper accepted by your readers as a statement of our views."

"The Sale of "Novak" Lamps Restrained.—An injunction has been granted in America against the "Novak" lamp."

Institution of Electrical Engineers.—On Thursday, January 25th, a paper will be read on "Notes of a Trip to the United States and to Chicago, 1893," by W. H. Preece, C.B., F.R.S., Past-President.

The Liverpool Overhead Railway.—The Chairman of this Company has been desired by his colleagues to express to Mr. Thomas Parker their satisfaction with the manner in which the Electric Construction Corporation has fulfilled its contract with the electrical equipment of the railway. The machinery has been well and substantially made, it is economical in working, and its efficiency may be gauged by the fact that during the ten months the line has been opened the company has run a five minutes' services of trains, and 96 per cent. have been on time. The directors feel that these excellent results are very largely due to the scientific skill, thought, and untiring industry of Mr. Parker, who we heartily congratulate on his success.

The Newport Electric Light Tenders.—Messrs. Willans and Robinson have sent the following letter to the South Wales *Daily Star*, under date of the 15th inst. :—

Sir,—We beg to enter our emphatic protest against the treatment which we understand our tender has received from the Electric Lighting Committee, upon the advice of Mr. R. Hammond. Where this gentleman has advised public bodies before we have recognised that he would recommend his own manufactures, or the manufactures of those with whom he was understood to be intimately associated, and we have made no attempt to tender or to interfere with the obsolete and inefficient system of driving used in the stations he has had to do with—a system which has the advantage, however, of being suitable for the make of engines invariably favoured by him. This time it was proposed to use, for one comparatively insignificant part of the plant, the system of direct-driving which has been for years in England the ordinary practice of all the best electric light engineers, and has lately become the practice in other countries as well. We tendered for this set (a combined engine and alternator), and find by one page of Mr. Hammond's "report" that our price was amongst the lowest—we believe the lowest for a *single-acting* engine, the only pattern suitable for such work, and it was about £200 lower than the tender of a firm of contractors who proposed to use our engine. On the next page we come to "recommendations." Three tenders figure here: one, the cheapest, for a *double-acting* engine, differing little in price from ours, and one for a single-acting engine *higher priced than ours*. Our tender, which is low, is excluded altogether, but our engine appears at £200 over our price, in the tender of the contracting firm referred to. Thus the Willans engine is not exactly shut out, but it is so brought in as to make its rejection certain. Some system of "allowances," we suppose, has been invented to justify this. In the inaugural address of Mr. Alexander Siemens, the President of the Institution of Electrical Engineers, last Thursday, it was stated that public lighting stations have been established, or are in hand, in this country, to the extent of 53,000 horse-power. Our books show that we have supplied or have orders for, about 40,250 horse-power of Willans engines for public stations of Great Britain; hence about three-quarters of all the public lighting work of this country is done by Willans engines of our make. In the year 1893 we received orders for electric light engines *for public lighting alone*, and for England alone, to the extent of over 10,000 horse-power, and installed about 8,000 more under orders received in the previous year. Every lighting engineer of the first rank will testify that it is largely the Willans engine which has rendered possible the present great development of electric lighting in England, and the fact is equally well known on the Continent, where the leading and most famous maker of slow-speed engines for electric lighting has become our licensee, and is putting down Willans engines in preference to the admirable Corliss engine of his own make. Our engines, to the extent of over 2,000 horse-power, drive alternating dynamos at Bristol (including several of 360 I.H.P. each) with an absolute success to which we are sure Mr. Preece, who is the engineer, would testify if applied to. At the great City of London lighting station at Bankside, there are Willans engines of 1,400 horse-power direct-coupled to some of the largest alternators in England, and it is a fact that it is the absolutely reliable running of this plant which alone enabled the company to maintain the city lighting comparatively free from interruption, in the face of a recent series of breakdowns of other plant employed in that station. Mr. Hammond is not so ill-informed as to be ignorant of the advantages of the Willans engine in lessened cost of coal, of oil, of attendance, and of repairs—in fact, in everything, in comparison with such plant as was specified for the main part of the Newport installation, but if the corporation chooses, in the face of all that is now known, to endorse the exclusion of the principle of direct-driving, we can make no complaint. But when tenders for direct-driving plant are invited the case is different, and we feel justified in saying that the proposed treatment of our tender for the one unimportant section left open to us is not what we had a right to expect from the Corporation of Newport.—We are, gentlemen, your obedient servants,—WILLANS & ROBINSON, LIMITED.

NEW COMPANIES REGISTERED.

Froggatt's Inventions Syndicate, Limited (40,231).—This company was registered on the 1st inst. with a capital of £1,000 in £1 shares, to purchase and acquire, in any manner, certain patent rights, &c., for the generation or storage of electricity, granted to or invented by Thomas Froggatt, or others, to develop those rights, and to carry on the business of electrical engineers, &c. The subscribers (with one share each) are: Wm. Price, 50, West Derby Street, Liverpool, contractor; S. Howarth, 53, Cotswold Street, Liverpool, gentleman; Jno. Martin, 8, Sugnall Street, Liverpool, clerk; R. C. Page, 106, Dacy Road, Liverpool, shorthand writer; A. Hampson, 120, Gladstone Road, Edge Hill, Liverpool, clerk; B. Brancher, 38, Fern Grove, Liverpool, solicitor; T. H. Derbyshire, 42, Bagot Street, Waverton, bookkeeper. Registered without articles of association by Hooper & Son, Ludgate Hill, E.C.

The Port Beira Pier, Tramway and Telegraph Company, Limited (40,268).—This company was registered on the 6th inst. with a capital of £150,000, in £1 shares, to carry into effect an agreement made between J. R. Davies, of the one part, and H. Edwards on behalf of the company, of the other part; to erect tramways, railways, quays, piles and wharves, to examine and explore lands, and to erect telegraphs, telephones, and electric works. The subscribers (with 1 share each) are: J. Heindorf, 39, Victoria Street, S.W., secretary; A. C. Heindorf, Hampstead Heath, commercial traveller; W. H. Talbot, Merton, commercial traveller; G. F. Rooker, Watford, gentleman; R. Elder, Islington, clerk; E. Roney, Camberwell, clerk; H. Bowles, East Dulwich, stationer. The number of directors is not to be less than three, nor more than seven; qualification, £500. The first directors are R. Bensusan, Count de Mendia, C. A. Moreing, and R. G. Webster, M.P. They will join the board after allotment. Registered by Hurrell & Mayo, 165, Queen Victoria Street, E.C.

CITY NOTES.

National Telephone Company, Limited.

MR. JAMES STAATS FORBES was in capital form when addressing the shareholders at yesterday's meeting, held at Cannon Street Hotel. That continuous stream of information, made the more palatable by a certain amount of agreeable humour, for which Mr. Forbes is conspicuous, was again and again received with applause by the honourable proprietors. The meeting was an extraordinary general one, for the purpose of submitting several proposals to the shareholders, and obtaining an idea as to their feeling in regard to them. From beginning to end the meeting was one of complete unanimity, which, by the way, is not the case with a great number of City companies—and the suggestion that two ordinary meetings be held in each year instead of one as formerly, was naturally received without any dissentients. The date of the financial year, which now commences in May, making the half-yearly dividends payable in April and October, is to be accordingly altered to January, thus when legally settled the next dividend paid will be for eight months ended June 30th, a new half-year commencing on July 1st, as is the case with the majority of commercial undertakings. Questioned as to the agreement between the company and the Government, the chairman said it was not the fault of the company that this had not yet been finally settled; the responsibility for the delay rested entirely with the State. A shareholder (Mr. Galbraith) thought it would be better were the reserve fund come-at-able rather than being invested in the business, and the chairman replying, stated that this was a question which had occupied the attention of the directors for the past six months, and sooner or later he thought it would be invested in some sort of funds instead of the business. In his comments upon the position of the company, the chairman said that during the last half-year they had purchased the Irish Telephone Company at a cost of £90,000. The total capital expenditure, including this, was about £121,000. All the preference shares and debentures had received their respective rates of interest, and they had paid 5 per cent. for the half-year on the ordinary shares, and carried a considerable amount to the reserve.

The Fowler-Waring Cables Company, Limited.

THE directors' report presented to the shareholders at the fifth ordinary general meeting, held at the registered offices of the company, Victoria Mansions, 32, Victoria Street, Westminster, London, S.W., on Friday last, the 12th inst., reads as follows:—

"The directors beg to submit herewith their fifth annual report. As will be seen on reference to the profit and loss account appended, the directors have passed their fees for this year to the credit of this account, which thus shows a net profit of £1,990 5s. 3d. Out of this profit the board proposes to write £1,329 off the value of shares in other companies, which now stands in the balance-sheet at £2,115, thus reducing this item for next year to £786, at which price they may safely be left for the present, and to carry forward the balance of £661 5s. 3d. to the credit of next year. These shares in other companies were taken in part payment of contracts, and practically represent the profit on cables supplied. The directors believe they will earn dividends, and become saleable at par or over in due course; but in the meantime they deem it desirable to reduce the estimated value. On turning to the balance-sheet shareholders will notice that the directors have placed the whole of the fees, hitherto credited, but not drawn by them, to the credit of that account, and they have thus been able to strike out the balance of loss as it appeared in last year's balance-sheet, and to write off £1,209 4s. 10d. from the preliminary expenses. No allowance has been made for depreciation of plant and machinery, but all has been fully maintained and repaired from revenue. The stock has been taken with great care, and valued throughout at or below cost. The year has been one of great depression in financial and commercial circles, and all who could have held back orders, as far as possible, for better times, but the company's business has continued to increase nevertheless, the sales being considerably in excess of last year, whilst the gross profits have, on the whole, and notwithstanding severe competition, been well maintained. In 1892, by circular, and again in their report of last year, the directors pointed out that the capital of the company was insufficient for its immediate requirements, and altogether inadequate to any large increase; they, therefore, made a temporary issue of £10,000 in 5 per cent. debentures, repayable in September, 1894. With the exception of £1,000 taken by one shareholder, the whole of this amount was either subscribed or guaranteed by directors. In view of the immediate necessity of providing additional capital to meet the growing business of the company, and to pay off the debenture debt, the directors are negotiating for a fresh issue of £25,000, on debentures to be secured against the general assets of the company, which in the meantime have largely increased, and afford, in the opinion of the board, ample security for such an issue. Meanwhile, the directors are still confident that, with sufficient capital and ordinary fortune, the company's affairs must continue to improve. The general manager's report is appended. The retiring directors are Lord Medway and Mr. Geo. F. Smart, both of whom are eligible, and offer themselves for re-election. The auditors, Messrs. Cooper, Bros. & Co., also retire, in accordance with the articles of association, but offer themselves for re-election."

General Manager's Report.

"The financial year with which this report deals has seen many further extensive applications of our cables, and we have had a considerable share of the work which has been carried out; but there has been a decided depression in our business, and in telephony, particularly, owing to the fact that the replacement of overhead by underground conductors, which is proceeding so actively in every other country in Europe, has been in England very greatly deferred. Everything, however, indicates an early extension of telephonic enterprise, and, as our cables have already secured a leading position, such extension cannot fail to beneficially affect the company. In all systems of electrical supply of any magnitude, and especially in the municipal lighting stations now spreading all over the country, the cost of the cables forms a very large proportion of the total expenditure, and it is of the first importance that the highest efficiency should be assured. In the competitive battle which wages round these large contracts, some of the older companies enter with a much larger record; we have, notwithstanding, secured several important municipal contracts, and wherever we have had the opportunity, we have at least equalled the best of our rivals' work. Only time is necessary to enable us to equal their records. Our customers among the engineers who carry out the wiring of buildings for the electric light have largely increased during the past year, and a number of extensive factories in this country and abroad have been entirely wired on our system. It is in this branch, however, that we are hampered by the most serious of our difficulties, and it is often impossible to secure the adoption of our lead-covered wires for work of this class. India-rubber covered wire, while more expensive, and, we believe, less efficient and permanent than lead-covered wire, is still more economical to fix and manipulate, and it is to be regretted that we have not been able fully to meet the demand for this wire. I hope, however, that we shall soon be able to do so. Meantime, the best methods of overcoming the difficulties in the application of lead-covered wires to small installations have been studied, with a large measure of success. The plant at Woolwich has been most carefully maintained and considerably added to. It has been our aim in the development of this business to closely apply the results of the most recent discoveries in those branches of applied science which have any bearing on our work. In competitive trials against other systems, the high efficiency of our manufactures has been repeatedly established. Our progress has not been so rapid as some anticipated, but it has been considerable, and has been on such safe and firm lines that we have every justification for confidence in the future.—Alfred E. Mavor, *General Manager.*"

The ordinary general meeting was held on Friday at the offices, Victoria Street, Westminster.

Mr. William Fowler presided, and, in moving the adoption of the report, regretted that the directors were not able to pay a dividend yet. They had, however, done all they could to assist the company, having waived their fees and helped it from time to time by the money they had advanced. The absence of dividend was attributable to the general depression of business last year, and especially to the great competition in their own business. They were endeavouring to obtain the additional working capital they required in a way which they hoped would be satisfactory, but if they should have to appeal to the shareholders he trusted that the latter would come to their assistance.

Lord Medway seconded the motion.

The Chairman, in reply to Mr. Walter Fletcher, stated that the turnover of the company in the past year was considerably greater than it was in the preceding year, but the profit was not so large proportionately, as, owing to competition, the estimates had had to be made on a somewhat less profitable scale. If they were to write off the item of "patents and goodwill" (£41,000), they would have to go to the Court, and for a certain time they would have to put the words "and reduced" after the name of the company. He thought that this would be objectionable, and that it would tend to reflect on the credit of the company.

After a few remarks from the General Manager (Mr. Alfred E. Mavor), who stated that their cables fully maintained their position, and that he did not think £41,000 would prove a very large sum for the ultimate goodwill of the company, the motion was adopted.

The Direct United States Cable Company, Limited.

The report of the directors for the six months ended December 31st, 1893, to be presented at the thirty-third ordinary general meeting of the company, to be held at Winchester House on Tuesday, January 23rd, at 2 o'clock p.m., reads as follows:—

"The usual statements of account for the half-year ended December 31st, 1893, are submitted herewith. The half-year's revenue, after deducting out-payments, amounted to £41,051 19s. 11d., as compared with £43,629 6s. 1d. for the corresponding period of 1892, being a difference of £2,577 6s. 2d. against the half-year under review. The working and other expenses for the same period, including income tax, amounted to £19,059 16s. 5d., leaving a balance of £21,992 3s. 6d. as the net profit, making, with £819 2s. 4d. brought forward from the previous half-year, a total of £22,811 5s. 10d. For the corresponding period of 1892 the working expenses and other payments amounted to £18,982 3s. 7d. Interim dividends of 3s. 6d. per share for the quarter ended September 30th, 1893 (paid October 24th, 1893), and of 3s. per share for the quarter ended December 31st, 1893 (payable January 24th, 1894), together amounting to £19,730 1?s., have been declared, and the balance of £3,080 10s. 10d. on the revenue account has been carried forward. The reconstruction of our station buildings at Ballinskelligs is being proceeded with. The directors announce with regret, that in consequence of failing health, Mr. Charles John Günther has resigned his seat at the board. The casual vacancy thus created in the board of directors has been filled up by the election of Mr. Charles Eugene Günther.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors held on 12th inst., it was resolved to recommend to the proprietors at the next half-yearly general meeting of the company, to be held on January 26th next, the declaration of the following dividends:—1. A balance dividend of 13s. 6d. per cent. upon the ordinary consolidated stock for the year ending December 31st, 1893. 2. A balance dividend of £1 7s. per cent. upon the preferred stock for the year ending December 31st, 1893, both payable on January 27th next, less income tax, to the stockholders registered on the books of the company on the 8th inst. After paying the foregoing dividends, there will be a balance of about £844 to be carried forward to the next account. The above dividends, together with those already paid, will amount to £2 11s. per cent. on the ordinary consolidated stock, and £5 2s. per cent. on the preferred stock, for the year 1893. The register of transfers will be closed from January 12th to January 26th, both days inclusive.

City and South London Railway Company.—The accounts for the past half-year show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of ¾ per cent. per annum, against a dividend at the same rate for the corresponding period last year, leaving a balance of £1,064 to be carried forward to the next account, as against £822 for the same period last year.

St. James's and Pall Mall Electric Light Company.—The directors recommend a dividend at the rate of 4½ per cent. per annum on the ordinary shares for the year ending December 31st, 1893.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 14th, 1894, amounted to £951; week ending January 15th, 1893, £1,008; decrease, £57; total receipts for half-year, 1894, £1,941; corresponding period, 1893, £2,006; decrease, £65.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 12th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,297.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, January 10th.	Closing Quotation January 17th.	Business done during week ended January 17th, 1894. Highest.	Lowest
184,500*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102 xd	99 —102	...	...
1,134,640*l*	Anglo-American Telegraph, Limited	Stock	42 — 44	43 — 45	43	42
2,932,680*l*	Do. do. 6 p. c. Preferred	Stock	79½— 80½	81 — 82	80⅝	79½
2,932,680*l*	Do. do. Deferred	Stock	7 — 7½	7⅛ - 8	7¼	7
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12	11⅛— 11⅜	11⅞	11⅛
18,700*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p.c., 2nd Series, repayable in June, 1906 ...	100	107 —111 xd	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅜ - 2⅝	2⅝— 2⅞	2⅝	2⅛
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2⅛	2 — 2⅛	2⅛	2 3/16
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	104 —106	104 —106	104⅛	104⅛
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4½— 5	4½— 5	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000*l*	City and South London Railway	Stock	28 — 33	28 — 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½ — 11⅝	11½— 11⅝	11⅝	11½
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	13 — 13½	13 — 13½	13⅜	13 3/16
10,000,000‡	Commercial Cable, Capital Stock	$100	130 —140	130 —140	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	3/16— 3/16	1/16— 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4 — 4½	4 — 4½	...	...
50,000*l*	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11½— 12½	11½— 12½	12¼	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	18	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ - 9½	8½— 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅛— 11⅜	11 — 11⅛xd	11⅜	11⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15½	15 — 15½xd	15 5/16	14⅞
70,000	Do. 6 p. c. Preference	10	15¾ — 16⅛	15¾— 16⅛xd	16 1/16	...
105,900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	114 —117	114 —117	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝— 15⅞	15½— 15⅝xd	15⅝	15 5/16
62,700*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	101 —104 xd	101 —104	...	...
222,800*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	101 —104 xd	101 —104	103½	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	115 —118	115 —118	116½	..
108,700*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104 xd	101 —104	...	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104 xd	101 —104	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
200,000*l*	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	106 —109 %	106 —109 %	106½	...
120,000	Electric Construction, Limited, Nos. 1 to 120,000	£2	½ — 1	½— 1	...	...
12,845	Do. do. 7 p. c. Cum. Pref., Nos. 1 to 12,845	2	1 — 1½	1 — 1½	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	... ...	... ...	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ - ⅜	⅛ - ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	0 — ¼	0 — ¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	¼ — 1½	¼— 1½	..	...
180,227	Globe Telegraph and Trust, Limited	10	8½ — 8⅝	8⅛ - 8⅜xd	8⅜	8 9/16
180,042	Do. do. 6 p. c. Preference	10	15⅜ — 15⅝	15¼ — 15⅜xd	15⅜	15¼
150,000	Great Northern Tel. Company of Copenhagen	10	19¾ — 20¼ xd	19¾— 20¼	20¼	20⅛
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½— 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22 — 23	23 — 24	23½	23
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 44	41 — 44	42½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ — 4⅝	4½— 4⅝	...	...
15,000	Do. do. fully paid	5	6⅜— 6⅝	6¼ — 6⅜	6¼	...
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	4⅝— 5⅛	5 — 5⅛	5	...
6,295	Do. do. Pref., £6 paid	10	8⅜— 8⅝	6½ — 6⅝	...	...
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£10 paid)	10	8 — 8½	8⅛ - 8⅜	8⅜	8⅛
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	104 —108	104 —108	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	¼— 1½	¼— 1½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	2 — 3	2 — 3	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 4⅞	4⅜ — 4⅞	4⅞	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14 — 15	15	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½— 14½	14 — 15	14½	...
119,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼— 5½	5¼— 5½	5½	5 5/16
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —114 xd	112 — 114	113	112½
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4⅜— 5⅛	4⅜ - 5⅛	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	100 —103 xd	101 —104	102	...
11,802	Reuter's Limited	8	5½ — 6½	5½— 6½	...	...
19,980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	5¾— 6¼	6 — 6½	6¼	6¼
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8⅜	8
3,381	Submarine Cables Trust	Cert.	114 —119	114 —119	114½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2½ - 2⅝ xd	2½ - 2⅝	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	36 — 38	36 — 38	37½	36⅜
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106 xd	103 —106	105¼	105
58,000	United River Plate Telephone, Limited	5	1½ - 2	1½ - 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100 xd	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	100 —103	101½	...
30,000	West Coast of America Telegraph, Limited	10	1½ - 2½	1½ - 2½	1⅞	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —101 xd	97 —101	...	...
64,242	Western and Brazilian Telegraph, Limited	15	6 — 6½	6 — 6½	6¼	...
†33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½ — 5¾	5½ — 5¾	5¾	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1½ - 1⅝	1½ - 1⅝	...	...
178,200*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	104 —107	106½	...
222,700*l*	Do. 5 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph, Limited	10	1 — 1¼	1 — 1¼	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9⅞ - 10¼	9⅞ - 10¼	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ - 9⅛	8½ - 9⅛	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108 xd	105 —108	108	107¼
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	113 —118	113 —118	...	...
169,000*l*	Do. do. 5 p. c. Sterling Bonds	100	102 —105	102 —105	...	...
69,960	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5 — 5⅛	5¼ — 5⅜	5⅛	5⅛

‡ Unless otherwise stated all shares are fully paid.

† Quotations on Liverpool Stock Exchange.

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) ⅛—6¼.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 106—108.—Electric Construction Corporation 6 per cent. Debentures 87—92.—Electric and General Investment, shares of £5 (£1 paid), 1⅛—1½.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—House to House Company (£5 paid) 1—1½.—Do. 7 per cent. Preference of £5, 5½—6¼.—Do. 6 per cent. Debentures of £100, 101—103.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 4⅞—5⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6⅛—6⅜.—Liverpool Electric Supply, £5 (fully paid) 6¼—6⅜.—Do. £3 10s. paid, 4¼—4⅜.—London Electric Supply Corporation. £5 Ordinary, ⅞—1⅛—Manchester, Edison and Swan Company £5 (£1 paid), ⅛—¼—Queen Anne's Mansions Lighting and Heating 6 per cent £100 Debentures, 121—103.—Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid) 4⅛—4⅜.

Bank rate of discount, 3 per cent. (October 5th, 1893.)

A DYNAMICAL THEORY OF THE ELECTRIC AND LUMINIFEROUS MEDIUM.*

By JOSEPH LARMOR, F.R.S., Fellow of St. John's College, Cambridge.

(*Concluded from page* 48.)

But if we add on to this the first assumption, no room will be left for the explanation of the pyro-electricity and piezo-electricity of crystalline media, by changes of orientation of polar molecules due to changes of temperature or to applied pressure. If this very rational explanation is to be retained, we are driven to assume that the electric force of the field does not sensibly alter the orientation of a molecule, which would then be wholly controlled by the internal electrical, chemical, and cohesive forces of the medium. The state of matters thus required is, in fact, precisely realised by a symmetrical arrangement of positive and negative atoms in the molecule, such as the hexagonal molecule recently imagined by Lord Kelvin† and earlier by J. and P. Curie, to account for the piezo-electric quality of quartz; the symmetry of the electric charges makes null the aggregate electric moment and therefore the turning couple in an electric field, while a differential polarity can still be developed under strain of the crystal.

According to the present theory of electrification, a discharge of electricity from one conductor to another can only occur by the breaking down of the elasticity of the dielectric æther along some channel connecting them; and a similar rupture is required to explain the transfer of an atomic charge to the electrode in the phenomenon of electrolysis. We can conceive the polarisation increasing by the accumulation of dissociated ions at the two electrodes of a voltameter, until the stress in the portion of the medium between the ions and the conducting plate breaks down, and a path of discharge is opened from some ion to the plate. While this ion retained its charge, it repelled its neighbours; but now electric attraction will ensue, and the one that gets into chemical contact with it first will be paired with it by the chemical forces; while if the conducting path to the electrode remains open until this union is complete, the ion will receive an opposite atomic charge from the electrode, which very conceivably may have to be also of equal amount, in order to equalise the potentials of the molecule and the plate. This is on the hypothesis that the distance between the two ions of a molecule is very small compared with the distance between two neighbouring molecules. A view of this kind, if thoroughly established, would lead to the ultimate averaging of atomic changes of all atoms that have been in combination with each other, even if those charges had been originally of different magnitudes. [The assignment of free electric charges to vortex atoms tends markedly in the direction of instability; though instability under certain circumstances is essential to electric discharge, yet it must not be allowed to become dominant.—*December 7th*, 1893.]

The presence of vortex atoms, forming faults so to speak in the æther, will clearly diminish its effective rotational elasticity; and thus it is to be expected that the specific inductive capacities of material dielectres should be greater than the inductive capacity of a vacuum. The readiness with which electrolytic media break down under electric stress may be connected with the extremely high values of their inductive capacities, indicating very great yielding to even a small electric force.

The radiation of a body into the surrounding medium is wholly electrical, and is due to the electric vibrations of the atomic charges; some of these types of vibration may correspond to the single atom by itself, while others will be considerably affected by the presence of the neighbouring atoms of the molecule. The most striking fact to be explained is the total independence of temperature that is exhibited by the periodic times corresponding to the various spectral lines. The extreme smallness of an atom implies correspondingly intense electrification, and therefore independence of the external field. If it is assumed that the dimensions and configuration of the atom are determined by the very intense actions between it and its partners in the molecule, and are not sensibly affected by the comparatively feeble influence of the velocity of translation of the molecule through the medium, this fact will be accounted for; irregularities can then only occur during an encounter with another molecule.

In the hydrodynamics of ordinary liquids, when the energy of an isolated vortex ring is increased, the ring expands in radius, and therefore moves onward more slowly. But in the case of an isolated charged atom, an expansion in radius diminishes the potential energy of the electric charge. These two agencies counteract each other; if the latter one is the greater, increase in energy will involve increase in velocity, as would be required in the ordinary form of the kinetic theory of gases. But the more natural supposition is, perhaps, to consider a molecule as composed of atoms paired so that the velocity of translation does not depend intrinsically on the amount of energy associated with the molecule, but is determined by the circumstances of the encounters with other molecules. The distribution of energy between the various vibration-types of the molecule, according to the law of Maxwell and Boltzmann, will not affect its configuration, while there is also perfect independence between the hydrodynamical motion of the medium due to the molecule and the radiation produced by it.

As regards the rotational elasticity of this hydrodynamical æther, on which we have made all radiative and electrical phenomena depend, it was objected, in 1862, by Sir George Stokes* to MacCullagh's æther, that a medium of that kind would leave unbalanced the tangential surface-tractions on an element of volume, and therefore could not be in internal equilibrium; and this objection has usually been recognised, and has practically led to MacCullagh's theory of light being put aside, at any rate in this country. Now, it has been already mentioned that a precisely equivalent objection will apply to the elasticity actually produced by a gyrostatic distribution of momentum in an ordinary solid medium, the only difference in the circumstances being that in the latter case the rotational elasticity is proportional to the angular velocity and not to the angular displacement;† and this remark suggests that there must be some way out of the difficulty. If we consider the laws of motion stated in Newton's manner with reference to absolute space and absolute time, as fundamental principles, then it is also a fundamental principle that the energy of a spinning gyrostat has reference to absolute space, and is not relative to the material system which contains it. The gyrostat may be considered as a kind of connection binding that system to absolute immovable space by means of the forcive which it opposes to rotation; and this is the reason why the element of mass in a gyrostatic medium remains in equilibrium with its translational kinetic reactions, although the tractions of the surrounding parts on its surface are unbalanced and result in a couple. If this mode of viewing the subject is regarded as incongruous, then we must discard from dynamics the notion of absolute space, and we must set out in quest of some transcendental explanation of the directional forcives in rotational systems. In any case the general Lagrangian dynamical procedure applies precisely to the gyrostatic medium we have here taken as an illustration; nor, probably, would its application to MacCullagh's æther be questioned, once the preliminary objection was removed.

This question may also be instructively illustrated from another side, by the consideration of an actual medium which possesses precisely the rotational elasticity of MacCullagh's æther. I allude to a solid medium with small magnets interspersed through it in any arbitrary manner, but so that in any single element of volume there is some regularity in their orientation. If this medium when unstrained is in equilibrium in a magnetic field, then when an element of it is displaced rotationally it will be acted on by a bodily couple arising from this exernal field; and therefore the surface tractions on the element would, in the presence of this couple, be unbalanced. Here the disturbing cause is a magnetic forcive arising either from the medium as a whole or from some external system; it has to be considered as of a statical character, that is, the velocity of propagation of the magnetic action is supposed to be indefinitely great compared with the velocity of propagation of any disturbances that are under discussion; the magnetic influence of the whole system is supposed to be instantaneously brought to bear on the element, and not merely the influence of the surrounding parts. On this saving hypothesis, the magnetic energy is here also correctly localised, for dynamical purposes, in the element of volume of the medium, and the Lagrangian method has perfect application to the mathematical analysis of its phenomena.

Now, in the case of the æther we have had at hand a *vera causa* precisely of this kind. The cause of the phenomena of gravitation has hitherto remained perfectly inscrutable. Though the present order of ideas forbids us to consider it otherwise than as propagated in time, yet all we know of its velocity of propagation is the demonstration by Laplace that it must, at the very least, exceed the velocity of propagation of light in the same kind of proportion as the latter velocity exceeds that of ordinary motions of matter. It is not unphilosophical to assume that an explanation of gravitation might carry along with it the explanation of the fact that the tangential tractions on an element of the strained æther are unbalanced. The dynamical phenomena of mass in matter would appear to be analytically explicable by the addition of a rotational part to the kinetic energy of the element of the medium; such a term is of course practically null except in the vortex rings.

In all that has hitherto been said we have kept clear of the complication of viscous forces; but in order to extend our account to the phenomena of opacity in the theory of radiation and of electric currents in ordinary conductors, it is necessary to introduce such forces and make what we can of them on general principles. It is shown that the introduction of the dissipation function into dynamics by Lord Rayleigh enables us to amend the statement of the fundamental dynamical principle, the law of least action, so as to include in it the very extensive class of viscous forces which are proportional to absolute or relative velocities of parts of the system. This class is the more important because it is the only one that will allow a simple wave to be propagated through a medium with period independent of its amplitude; if the viscous forces that act in light propagation were not of this kind, and on passing a beam of homogeneous light through a metallic film it should emerge as a mixture of lights of different colours. The viscous forces being thus proved by the phenomena of radiation to be derived from a dissipation function, it is natural to extend the same conclusion to the elastic motions of slower periods than radiations, which constitute ordinary electric disturbances. We thus arrive, by way of an optical path, at Joule's law of dissipation of electric energy, and Ohm's linear law of electric conduction, and the whole theory of the electro-dynamics of currents flowing in ordinary conductors; though the presumption is that the coefficients which apply to motions of long period are not the same as those which apply to very rapid oscillations, the characters of the matter-vibrations that are comparable in the two cases being

* Abstract of paper read before the Royal Society. (Received November 15th, 1893.)

† Lord Kelvin, *Phil. Mag.*, October, 1893.

* [I am informed by Sir George Stokes that in the above criticism he contemplated only media of which the elements are self-contained, and devoid of internal motions.]

† For a detailed discussion of equilibrium and wave-propagation in such a medium, see *Proceedings* Lond. Math. Soc., 1890.

quite different.* If it is assumed that the form of the dissipation function is the same for high frequencies as for low ones, we obtain the ordinary theory of metallic reflexion, which differs from the theory of reflexion at a transparent medium simply by taking the refractive index to be a complex quantity, as was done originally by Cauchy, and later for the most general case by MacCullagh. And, in fact, we could not make a more general supposition than this for the case of isotropic media; while for crystalline media the utmost generality would arise merely from assuming the principal axes of the dissipation function to be different from those of the rotational elasticity, a hypothesis which is not likely to be required.

It has been pointed out, originally by Lord Rayleigh, that to fit this theory to the facts of metallic reflexion it is necessary to take the real part of the index of refraction of the metals to be a negative quantity, which can hardly be allowed on other grounds, as it would inply instability of the medium. We might, indeed, following the view of Willard Gibbs and others, imagine an interaction between the light wave and the free vibrations of the atomic electric charges, and through them the chemical vibrations of the atoms, owing to proximity of their periods; and we might possibly conceive the electric medium to be, so to speak, held together by this kind of support. But I think there is another and simpler alternative that merits examination; we might conceive the opacity at the surface to be so great that a sensible part of the light is lost before it has penetrated more than a very small fraction of a wave-length. In the extreme case of electric waves of finite length reflected from metals, the absorption is complete in a very small fraction of the wave length, and the result is total reflexion, as from a vacuum; on the other hand, if the opacity is but slight, the phenomena ought to agree approximately with those of transparent media. It seems worth while to examine the consequences of assuming that the optical phenomena of metallic reflexion are nearer the first of these limiting cases than the second. It seems worth while to compare the facts for some medium not so opaque as metals with the formulæ of Cauchy and MacCullagh; the examples of tourmaline crystal, and some of the aniline dyes which exhibit selective absorption, suggest themselves as affording crucial tests.†

The considerations which have here been explained amount to an attempt to extend the regions of contact between three ultimate theories which have all been already widely developed, but in such a way as not to have much connection with one another. These theories are Maxwell's theory of electric phenomena, including Ampère's theory of magnetism and involving an electric theory of light, Lord Kelvin's vortex-atom theory of matter, and the purely dynamical theories of light and radiation that have been proposed by Green, MacCullagh, and other authors. It is hoped that a sufficient basis of connection between them has been made out, to justify a restatement of the whole theory of the kind here attempted, notwithstanding such errors or misconceptions on points of detail as will unavoidably be involved in it.

[While writing this summary it had escaped my memory that Lord Kelvin has proposed a gyrostatic adynamic medium which forms an exact representation of a rotationally elastic medium such as has been here described.‡ If the spinning bodies are embedded in the æther so as to portake fully in its motion, the rotational forcive due to them is proportional jointly to the angular momentum of a gyrostat and the angular velocity of the element of the medium, in accordance with what is stated above. But if we consider the rotators to be free gyrostats of the Foucault type, mounted on gymbals of which the outer frame is carried by the medium, there will also come into play a steady rotatory forcive, proportional jointly to the square of the angular momentum of the gyrostat and to the absolute angular displacement of the medium. An ideal gyrostatic cell has been imagined by Lord Kelvin in which the coexistence of pairs of gyrostats spinning on parallel axles in opposite directions cancels the first of these forcives, thus leaving only a static forcive of a purely elastic rotational type. The conception of an æther which is sketched by him on this basis§ is essentially the same as the one we have here employed, with the exception that the elemental angular velocity of the medium is taken to represent magnetic force, and in consequence the medium fails to give an account of electric force and its static and kinetic manifestations. A gyrostatic cell of this kind has internal freedom, and therefore free vibration periods of its own; it is necessary to imagine that these periods are very small compared with the periods of the light waves transmitted through the medium, in order to avoid partial absorption. The propagation of waves in this æther, having periods of the same order as the periods of these free vibrations, would of course be a phenomenon of an altogether different kind, involving diffusion through the medium of energy of disturbed motion of the gyrostats within the cells.

Lord Kelvin has shown that a fluid medium, in turbulent motion owing to vorticity distributed throughout it, would also possess rotational elasticity provided we could be assured of its permanence. Prof. G. F. FitzGerald proposes to realise such a medium by means of a distribution of continuous vortex filaments, interlacing in all directions; if the vorticities of the filaments in an element of volume are directed indifferently in all directions, the motional part of the kinetic forcive on the element, which depends on the first power of the vorticity, will be null, while the positional part depending on the square of the vorticity will remain, just as in the gyrostatic medium above considered. The atoms may now be imagined to consist of vortex rings making their way among these vortex filaments, and thus a very graphic and suggestive scheme is obtained; the question of stability is however here all-important. No ultimate theory can be final; and schemes of the kind discussed in this paper may not inaptly be compared to structural formulæ in modern chemistry; they bind together phenomena that would otherwise have to be taken as disconnected, though they are themselves provisional and may in time be replaced by more perfect representations.

The electric interpretation of MacCullagh's optical equations, which forms the basis of this paper, was first stated so far as I know by Prof. G. F. FitzGerald, *Phil. Trans.*, 1880. I have recently learned, from a reference in Mr. Glazebrook's address, British Association, 1893, that an electric development of Lord Kelvin's rotational æther has been essayed by Mr. Heaviside, who found it to be unworkable as regards conduction-current, and not sufficiently comprehensive (*Phil. Trans.*, 1892, Section 16; "Electrical Papers," Vol. ii., p. 543). A method of representing the phenomena of the electric field by the motion of tubes of electric displacement has been developed by Prof. J. J. Thomson, who draws attention to their strong analogies to tubes of vortex motion.

Prof. Oliver Lodge has kindly looked for an effect of a magnetic field on the velocity of light, but has not been able to detect any, though the means he employed were extremely searching; the inference would follow, on this theory, that the motion in a magnetic field is very slow, and the density of the medium correspondingly great.—*December 18th*, 1893]

* It is interesting to notice that, already in his memoir of 1864, Maxwell is struck by the identity of the coefficients of the free æther for all periods, which "shows how perfect and regular the elastic properties of the medium must be when not encumbered with any matter denser than air."

† [An alternative view, in many respects preferable, is supplied by the assumption, with Sir George Stokes, of the existence in metals of an *adamantine* property, such as was discovered by Airy for the diamond. *Cf.* Sir G. G. Stokes, *Proc. Roy. Soc.*, February, 1883.]

‡ Lord Kelvin (Sir W. Thomson), *Comptes Rendus*, September 16th, 1889; "Collected Papers," Vol. iii., 1890, p. 467.

§ Lord Kelvin (Sir W. Thomson), "Collected Papers." Vol. iii., 1890, pp. 436—472.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Inaugural Address of Mr. Alexander Siemens, M.Inst.C.E., President.

(*Abstract.*)

It may not be out of place to analyse the various factors which have influenced the development of our profession from the time at which telegraphy was the only important practical application of electricity, until now, when it is called upon to supply energy for an immense variety of purposes.

During the past 22 years our profession, and with it the Society of Telegraph Engineers, have changed their character, until these and the scope of their activities have become much more comprehensive, and much more intimately connected with the everyday life of the general public.

The Electric Lighting Act, 1882, which was the outcome of the discussions before a select committee, has given rise to angry denunciations on account of the obstacles which, in the opinion of many, it was raising to an early introduction of lighting by electricity on a large scale.

In order rightly to understand the influence which this legislation exercised on the development of the electrical industry, it is necessary to examine into the character and the number of the applications made to the Board of Trade under the Act and its amendments, and to trace how many of them have led to the establishment of distributing systems.

Taking first the case of the electric light companies, or, as the Act calls them encouragingly, "the undertakers," we find that in 1883, 55 provisional orders were granted, all of which have been revoked; in 1884, three provisional orders and one license were granted, all of which have been revoked; in 1885, one license was granted for the lighting of St. Austell, and this has been put into operation; in 1886, one provisional order was granted to the Chelsea Electricity Supply Company: this also has been carried out; four licenses granted during the two following years, 1887 and 1888, have since been revoked; so that, up to the time of the passing of the amending Act, 1888, one license and one provisional order are the sole survivors.

These facts clearly indicate that under the Electric Lighting Act, 1882, the undertakers have not succeeded in their object to make electrical energy obtainable as a household commodity. It is, of course, quite another question whether there were not very strong causes of another kind which prevented the powers obtained under the Act from being exercised.

Since the Electric Lighting Act, 1888, was passed, a new impetus was given to these enterprises, and, without examining the result of each year's applications separately, the grand total of the undertakers' efforts is that since 1882, 138 provisional orders have been applied for, and 15 licenses; of these, 81 provisional orders and nine licenses have been revoked, so that 57 provisional orders and six licenses are still in force. To this number two provisional orders have to be added, which have been transferred from local authorities to undertakers.

An electric supply has been established, or the work is actually taken in hand, in 54 cases, and about 53,000 horse-power will be available. On the other hand, of local authorities, a few had obtained powers under special Acts. The City of London, as mentioned above, had been able to make some experiments of street lighting without any special permission; but a number of them availed themselves of the opportunity given by the Electric Lighting Acts, and obtained 121 provisional orders and six licenses up to 1892.

Of this number, eight provisional orders and four licenses have

been revoked, or merged in provisional orders, so that 113 provisional orders and two licenses granted to local authorities are still in force; but two of the provisional orders have been transferred to undertakers, as mentioned above.

Under these powers 51 electrical systems of distribution, with 35,000 horse-power, have been established, or are in course of construction, while in almost all the other instances the intention soon to carry out the work is apparent.

From the figures which I have given, it is plainly apparent that the local authorities will very shortly have a good many more stations at work than the electric lighting companies; and, in my opinion, this is as it should be.

The financial success which has invariably attended the municipal electric enterprises has relieved the rates at the expense of the wealthier classes in a perfectly legitimate manner, and the more electricity becomes one of the common necessaries of life, the better it is that its supply should be in the hands of the community, and not in those of monopolists.

Fortunately for the progress of our industry, there were some corporations who could be convinced by the result of their enquiries that the use of electric light would be very advantageous for a variety of purposes, and that the knowledge and ability of the electrical engineers had progressed sufficiently to make a profitable distribution of electricity from a generating centre possible.

We have seen that their example has been largely followed, and there is every prospect of a continuous and ever-increasing development of this branch of electrical engineering.

To be sure, in foreign countries, especially in the United States, the use of electricity is much more common than here; but this is the natural outcome of the greater facilities for establishing centres of supply under the laws of the various countries, where the local authorities in the majority of cases have the power to make agreements with electrical companies for supplying the district with electrical energy for various purposes.

Another important factor in retarding the spread of the applications of electricity in this country is the otherwise very laudable desire of the electrical engineers to show in every new undertaking a distinct advance on its predecessors.

In this way the details of construction are undergoing a constant change—in strong contrast to the United States, where the leading manufacturers have their standard sizes of plant and accessories; these are manufactured wholesale by specially designed machinery, and can therefore be supplied much more cheaply than apparatus specially constructed for each case.

At the same time the whole transaction is greatly simplified by the absence of long negotiations about the construction of the apparatus, the town which is to be lighted simply specifying how many glow lights and arc lights are to be supplied.

This system of working has certainly been instrumental in accelerating the introduction of electricity for a variety of uses throughout the States; but it can hardly be pretended that such a cast-iron application of the same apparatus under a variety of circumstances can lead to the most economic results, nor has it been possible to keep up the quality of the work to the English standard.

Those of you who have visited the World's Fair at Chicago last year, and have examined a little into the details of workmanship and design, will doubtless agree that Sir Richard Webster was fully justified, in his address to the Society of Arts, in contrasting the American and the English exhibits in this respect, very much in favour of the latter.

While electrical engineering is allied to physical science, it has quite as intimate a relation to mechanical engineering; in fact, its real progress dates from the time when the close connection of electrical and mechanical engineering was thoroughly recognised; and since then these two branches of engineering have reacted on one another to their mutual advantage.

The contrast between present practice and that of the pioneers of our profession is at once recognised in reading the first papers and reports on dynamo-electric machines, where particular stress is laid on the small size and on the low weight of a dynamo to produce a given result; but the necessity of having the moving parts durable, and of not always working the machine up to its maximum power, was completely ignored in the desire to produce a large effect with the minimum expenditure of materials.

A glance at a modern dynamo, especially when it is built on the same lines as a machine of 20 years ago, will at once reveal the progress of mechanical design that has taken place in the interval.

The requirements for driving dynamos to the best possible advantage have served as no mean incentive for mechanical engineers to introduce a number of important improvements into the design of steam engines; in fact, the class of high speed economical engines may be said to have been called into existence by them, and this has led to the use of direct-driven dynamos, in which this country undoubtedly has taken the lead.

In another direction the governing of the speed of the steam engines has been vastly improved, although at first the mechanical engineers regarded the complaints of the electrical engineers simply as an excuse to shift the blame for the bad performance of their dynamos on to the steam engine.

They very soon learned, however, the importance of running at an unvarying speed, and the result is that even comparatively cheap steam engines can be obtained nowadays that govern infinitely better than a high-class engine of 20 years ago.

By far the most important connection between mechanical and electrical engineering is the transmission of power, which has of late acquired so much prominence.

The success of electric tram lines has undoubtedly contributed to direct general attention to the transmission of power by means of electricity, but great care will have to be exercised so as not to start in a direction that can lead to no practical results.

Many schemes have been started to introduce electricity as the motive power on the main lines of railway, and to accelerate at the same time the speed of the trains very considerably, even up to 200 miles per hour.

It would be rash to say that such a speed will not be attained some day, but in my opinion none of these schemes can be carried out on a commercial basis with the means at present at our disposal.

Trebling the speed of the trains necessitates a radical alteration in the laying of the permanent way, a thorough reconstruction of the carriages, and demands an amount of power that we have no means at present of estimating accurately, nor have we motors that could produce it with a moderate weight.

Even if these obstacles are overcome, the enormous capital outlay could only be justified if a very frequent service was kept up, as in the case of successful electric tramways. In most schemes it is, in fact, proposed to run single carriages at short intervals between important towns; but up to the present time it has not been possible to convince capitalists that such a service would pay, either between Vienna and Buda-Pesth, or between Chicago and St. Louis, which are the most notable instances of such schemes.

Besides traction, there is the distribution of power, in which mechanical engineering is of the greatest influence on the successful application of electricity.

It is, of course, a purely electrical problem to deliver your current either at a standard voltage, or in a constant quantity, at all points of your network of mains; but the application of the motors to the work they are required to do, and the determination of their dimensions, involve principally mechanical considerations.

How much there is still to be done in this respect was made apparent during the discussion of Prof. Forbes's paper on the proposed utilisation of water power at the Niagara Falls. Although the prevailing opinion seemed to be that for transmission to a great distance alternate currents only can be utilised, I believe that of the actually established long distance transmissions the greater part are worked with continuous currents.

No hard-and-fast rule can apparently be laid down that either the continuous or the alternate current should be preferred in all cases where power has to be transmitted to a distance; and in judging of the merits of the two systems, the proper conclusion can only be arrived at if the commercial aspect of the case is allowed to decide the question.

Another great field for electric motors is just being opened by their introduction for distributing power in works, with a view of abolishing shafting, leather belts, and other intermediate gearing, and of giving each lathe or other tool an independence that cannot be attained under the present system.

A most interesting paper on this subject was read by M. Castermans before the Society of Engineers, in Liége, in August, 1892, in which he compares in detail several proposals for distributing power in a new small arms factory, that has since been erected at Herstals.

The result he arrived at was that with electrical motors he could exert on the working machines 70 per cent. of the power generated by the main engine, while the next best other method gave only 63 per cent., when the shops were working at their full capacity.

In these problems, again, mechanical engineering questions decide whether the application of electricity is justifiable; and it is quite apparent that an electrical engineer requires to be well versed in a variety of subjects if he wishes to keep in the front rank.

The co-operation of science and practice is essential for all real success, and no doubt it appears to be superfluous to insist on the necessity of bearing this in mind; but a perusal of patent specifications will at once convince you that either the one or the other factor is sadly wanting in many would-be inventers.

Years ago it was science that was most conspicuous by its absence in these documents; but in the present time it is very often obvious that the inventor has no clear conception how his invention could be carried out so as to make it useful to mankind, and even fails to see the obvious impossibility of realising his ideas in the way he claims in the specification.

As usual, it is very difficult to steer the middle course; and if the scientific man had for years to cry in the wilderness because his pursuits did not receive the proper attention in the education of engineers, it seems now to be the turn of the practical man to warn students that there is something more to be learned besides scientific truths before they can aspire to be recognised as engineers.

It has always appeared to me that at school the mental powers should be principally exercised in a way to make them fit for learning, and that at the same time they should become accustomed to the careful consideration of a problem in its various aspects. Although it has been the fashion of late to deprecate the study of Latin and Greek, I am quite certain that the attack is made from quarters where the mental training which the study of these languages entail is not appreciated at its right value, nor is the enormous advantage considered which their knowledge gives in the study of modern languages.

After the mental powers have been prepared in this way, it is of no great consequence whether most of the details of the school teaching are speedily forgotten or not; the essential point is that the student should have acquired a good method of learning, so as to assimilate to the best advantage the course of training he attends at college.

While the teaching at school has a general character, and embraces chiefly subjects that ought to be known to all classes, at college the various professions are differentiated, and in each branch the students learn the general principles that ought to govern them in their future career.

Formerly, it was possible to let the course of scientific studies embrace all that was known in any particular branch; in fact, the general principles and the interdependence of the various branches were not, and partly are not yet, properly understood.

To attempt a similar course at the present time is simply impossible, and the danger that has to be avoided in our scientific colleges is the tendency to teach our profession too much in detail.

Besides overwhelming the professors with work, such a course is apt to create in the students the conviction that on leaving college with a first-class certificate they know all that can possibly be known, and that anything that does not fit in with the theory of their pet professor must necessarily be condemned.

A fault into which young men are liable to fall, when they come full of honours from college, is that they consider the passing through workshops beneath their dignity, especially when they have attended for the prescribed time in the workshop of the college. They quite forget that the practical conditions that prevail in works where machinery is made for sale differ entirely from those of a laboratory, where the only aim is to give the students an opportunity of acquiring manual skill.

Another class of students commences practical work with the greatest interest, and the fixed determination to introduce with all possible speed the various improvements which the difference of the practical work with which they come in contact from the teaching at college suggests to them.

On all these students it cannot be impressed too much that the practical training is of quite as much importance as the scientific course at college; in fact, in most cases the conclusions of pure science have to be modified by practical considerations before a useful application of science can be produced.

For this reason it is highly desirable that the teaching at engineering colleges should be confined to general principles, as far as the applications of science are concerned; but that the students should become thoroughly well acquainted with the mental tools that are used in scientific investigations, such as mathematics, the general principles of chemistry, and of the branches of natural philosophy.

While the student is trained afterwards in practical work, he has time to select what special branch of the profession he wishes to devote his life to, and no doubt he will find that his college studies have to be supplemented by reading up the various technical works referring more particularly to the selected branch.

If he has been able to acquire a certain knowledge of modern languages, he will find his labours lightened very materially by having a much larger range of literature to select from.

In this respect electrical engineering has been especially fortunate, for it has more than any other profession an international character, and this institution has from the very commencement counted among its members distinguished electrical engineers of many nationalities.

One of the most important international conventions is the Postal Union, into which most nations of our globe have entered, and whose influence is brought home to us every day.

In another direction an effort has lately been made to make the mode of reckoning time more uniform, and the result is that Greenwich time has practically been adopted in a great many civilised countries, by making the local time either the same, or differing from Greenwich by one hour or by multiples of an hour.

An even more important agreement among many nations has existed now for more than a quarter of a century by their adopting the metrical system of measurement; and it is well worth while seriously to consider the effect of this concerted action on the part of foreign nations, as it forms an ever-increasing obstacle for the successful competition of English manufacturers.

When we recollect that it was a German professor who suggested the absolute system of measurement, that the British Association first established practical electrical units, that the metrical system is of French origin, and that the electrical system of measurement was elaborated by discussions between engineers and scientific men of all nations at the various congresses, we cannot wonder that a very perfect system has been the outcome, and that its general adoption in all countries has followed without discussions, although the formal recognition may not yet have been pronounced in all cases.

Even in this system it has been found necessary to settle one of the units—the ohm—in an arbitrary manner, as it was recognised that for practical purposes it was better to have an arbitrary but fixed standard, than to correct the unit every time that an improvement in methods or in instruments admitted of determining it with greater accuracy than before.

It is well worth while to reflect on the lesson which this fact conveys, viz., that, in spite of the earnest endeavours and the painstaking collaboration of most competent men, it has not been possible to follow out in practice the dictates of pure science, but that a compromise was found to be inevitable.

NEW PATENTS—1894.

4. "Improvements in electricity meters." A. B. SCHUER. (Communicated by J. Cauderay, Switzerland.) Dated January 1st.

6. "Electrically heated brands and stamps." G. BINSWANGER. Dated January 1st.

12. "Improvements in electrical indicators." A. W. STEWART. Dated January 1st.

46. "Improvements in electrical apparatus for controlling traffic on single lines of railway." W. R. SYKES, jun., and A. G. EVANS. Dated January 1st.

57. "Improvements in electric motor apparatus." W. A. JOHNSTON, A. W. BROWNE, and J. C. DAVIDSON. Dated January 1st. (*Complete.*)

62. "Improved method of and apparatus for synchronising alternating current dynamo-electric machines, and switching them on and off mains." J. A. KINGDON. Dated January 1st.

67. "Improvements in and connected with arc lamps." L. C. H. MENSING. Dated January 1st.

84. "Improvements in reduction gearing for steam turbines." J. S. RAWORTH. Dated January 2nd.

92. "An improved bracket or hanger for electric lamps." J. P. HEBENDAHL. Dated January 2nd.

95. "Improvements in telephonic transmission and in the art generally of distributing or transmitting alternating currents for power and other purposes." W. H. ECKERT. Dated January 2nd. (*Complete.*)

124. "Improvements in the construction of steam turbines." J. S. RAWORTH. Dated January 2nd.

130. "Improvements in electric light appliances." A. H. WILDY. Dated January 2nd.

135. "Improvements relating to the transmission of electric currents and to conductors therefor." M. I. PUPIN. Dated January 2nd. (*Complete.*)

139. "Improvements in telephone exchange systems." R. CALLENDER. Dated January 2nd. (*Complete.*)

140. "Improvements in telephone exchange systems." R. CALLENDER. Dated January 2nd. (*Complete.*)

159. "Revolving automatic telescopic sight for coast batteries." L. K. SCOTT. Dated January 3rd.

191. "Improvements in dynamos." N. S. KEITH. Dated January 3rd.

192. "Improvements in electric drills or reciprocating motors, and in dynamos for working the same." N. S. KEITH. Dated January 3rd.

205. "Automatic compensators for neutralising the magnetic effects of dynamos and motors on board ships." S. EVERSHED. Dated January 4th.

207. "Improvements in electrical transformers and apparatus connected therewith." S. Z. DE FERRANTI. Dated January 4th.

214. "Improvements in apparatus for transmitting movements for actuating mechanism at a distance, for telegraphing, indicating, and for analogous purposes." S. ALLEY. Dated January 4th.

249. "Improvements in electric switching apparatus, more especially intended for use on electrically propelled vehicles carrying both the source of electricity and the motors." F. KING. Dated January 4th.

267. "An improved electric bell indicator." W. V. HUNT and W. HUNT. Dated January 5th.

281. "An improved fuel economiser." J. MURRIE. Dated January 5th.

294. "Improvements in type-printing telegraphic apparatus." W. P. THOMPSON. (Communicated by J. Kustermann, Germany.) Dated January 5th.

334. "Improvements in fastenings for electric light shades or globes." P. H. JAUNCEY. Dated January 6th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

18,165. "Improvements in telephonic apparatus." H. H. LAKE. (Communicated from abroad by E. Noriega, of Mexico.) Dated October 11th. Consists in a combined transmitter and receiver formed of an angular handle-piece, carrying at one end a microphone and at the other end a magnetic receiver, and in the combination therewith of an auxiliary transmitter and receiver, by means of which conversation can be carried on by two persons through one instrument. 3 claims.

19,248. "Improvements in conduits for electrical conductors." C. E. WEBBER, J. S. RAWORTH, and T. O. CALLENDER. Dated October 26th. The inventors make the insulated ways for the conductors of electricity of tubes of paper, paper compound or other substance having equivalent, or nearly equivalent, properties of insulation resistance. These tubes are made with spigot and faucet ends, or otherwise, in such manner that they can be jointed longitudinally by insertions one into the other. They are inserted into the way or ways of a conduit or casing which may be made of earthenware, mastic compound, or any other suitable material, preferably of low electrical conductivity, and sheathed or not with iron. It is an important feature of the invention that in the jointing of these tubes, the joints thereof are invariably arranged to break joint with the joints of the sections of the containing conduit or casing. Before insertion the paper tubes are treated with paraffin or other suitable composition to ensure tight joints, and so as to fill interstices. 2 claims.

19,543. "Improvements in electric telegraphic apparatus." L. B STEVENS. Dated October 31st. Consists essentially of a sending or transmitting instrument having a number of contact keys corresponding with an equal number of division spaces on the dial of a receiving instrument, the two instruments being electrically connected in such a manner that, on the depression of any contact key of the sending or transmitting instrument, an index pointer on the receiving instrument is rotated until it reaches a corresponding division space on the said indicating dial. 14 claims.

19,919. "Improvements in or relating to electric conductors." G. F. DE SOLOME. Dated November 5th. Relates to a new or improved manufacture of electric conductors and of joints therefor. The inventor takes lengths of any suitable insulating material whereon a

metal may be electro-deposited, or he takes lengths of suitable insulating material in which he cuts channels or grooves (in imitation of ordinary wood casing). He then places the lengths of material in an electro-depositing bath and deposits copper, or other desired metal, in any of the well-known ways, in such a manner as to form conductors (similar to ordinary drawn wire laid in the grooves of ordinary wood casing). 4 claims.

20,445. "Improvements in electric meters." C. RAAB. Dated November 11th. Relates to electric meters comprising an electromotor which actuates a counting train and an electro-dynamic damping or retarding device which absorbs the surplus power of the motor. 6 claims.

21,147. "Improvements in and relating to electric vehicles for use on roads." C. R. GARRARD and T. W. BLUMFIELD. Dated November 21st. Consists essentially in the combination and construction of a vehicle having four or more wheels with a frame composed of upper and lower main tubular, or other members, terminating at the fore end in bearings, in which fits a vertical tubular or solid shaft. 3 claims.

21,169. "Improvements in regulating apparatus for electric arc lamps." J. DULAIT. Dated November 21st. Relates to a new regulating apparatus for arc lamps for regulating the distance apart of the carbons, whether according to the volts of the lamp current, or according to the ampères, or according to both combined, whereby the faculty of differentiation is obtained. 4 claims.

21,693. "An improved electrical meter and recorder." P. FEYS and J. LORWA. Dated November 28th. The motor consists of a coil of fine wire, receiving the current from a balanced bar carrying a piece of iron which, when the current is passing, is attracted by the coil, and when the current ceases is pressed back by a spiral spring. Each attraction of the balance bar actuates an eccentric on the same axle, which moves forward one tooth of the toothed wheel attached to the recording instrument. 3 claims.

21,696. "Improvements in electric smelting of aluminous and other refractory ores or compounds." T. L. WILLSON. Dated November 28th. Consists essentially in subjecting to the heating action of an electric current a metallic compound in a fine state of subdivision or pulverisation, and impregnated with a suitable reducing agent, so that substantially each particle of the compound to be reduced carries with it the agent for its own reduction, by the latter either permeating it or coating it, or being otherwise attached to it. 8 claims.

21,803. "Improvements in electric transformers." C. E. L. BROWN. Dated November 29th. Has reference to improvements in the construction of electric transformers suitable for ordinary or single phase alternating currents." 8 claims.

21,811. "Improvements in multiphase alternating current motors without separate excitation." C. E. L. BROWN. Dated November 29th. Has reference to a motor distinguished by the special construction of the windings for the inducing and induced portions thereof, and also by improved constructional details. 3 claims.

21,917. "Process and apparatus for igniting the combustible charges or gas mixtures of gas and oil engines." J. WETTER. (Communicated from abroad by J. Rademacher, of Berlin.) Dated November 30th. A portion of the combustible mixture of gas or oil with air, conducted into the cylinder to serve for the next explosion, is separated from the rest and heated (in a chamber separated from the cylinder) at a low pressure (preferably the lowest pressure existing in the cylinder), which heating in the case of a four-cycle engine may take place during the period of compression of the mixture contained in the cylinder. Shortly before ignition, this separated combustible mixture is rapidly compressed to the maximum pressure existing in the cylinder, and simultaneously set in communication with the gaseous mixture contained in the cylinder. By the rapid compression (without taking off heat) the temperature of this mixture is raised above the igniting point of the same, the whole of the said mixture ignites suddenly and starts the combustion of the cylinder mixture, which now communicates with the same. 3 claims.

22,035. "Improvements in electrical switches and other fittings." G. BINSWANGER. Dated December 1st. Consists first in a new method of attaching the key or handle to the moving bar in such a manner that the said key or handle may be readily and quickly detached, in order to allow the cover of the switch to be taken off or put on, which method of attachment may also serve to retain the cover in position. Also relates to the cam for operating the moving contact bar, and to the spring actuating the same. 5 claims.

22,061. "Improvements in or in connection with an electric motive power system." W. L. SPENCE and D. STEWART & Co., LTD. Dated December 2nd. Relates more particularly to an electric rail or tramway system, but it is also applicable, in part, to other purposes. 7 claims.

22,129. "An improvement in electric switches for currents of high potential." C. J. WHARTON. Dated December 3rd. Consists of a flapper or shutter, applied to a switch in such manner that the action of opening the switch automatically releases the flapper or shutter, which descends with great rapidity, causing a draught of air which tends to blow out the "arc" or flame formed upon interrupting the circuit, and furthermore the flapper completely covers the aperture through which contact is made, thereby cutting off communication between the fixed and movable contacts of the switch. 2 claims.

22,261. "Improvements in electric arc lamps." A. F. HILLS. Dated December 5th. Claims:—1. The improved construction and arrangement of electric arc lamp, described and shown in the drawings. 2. The combination of a flexible conductor supporting the upper carbon holder, and wound on a spring drum, a hinged frame carrying the said drum, and clockwork escapement mechanism for regulating the feed of the carbon, with electromagnetic arrangements for effecting the movement of the rocking frame, all arranged and operating substantially as described with reference to the drawings. 3. Mounting the winding drum of the flexible conductor supporting the upper carbon holder of an electric arc lamp in a hinged frame, the rocking of which frame in the manner described with reference to the drawings, lifts the carbon holder to strike the arc. 4. The specially curved iron horns and poles for the magnet and armatures as shown and described, and for the purpose set forth.

22,271. "Improvements in and connected with carbons for electric arc lamps." C. W. HAZELTINE. (Under International Convention.) Dated May 6th. The carbons are first given a coating of copper, which should be very thin, and about the same as the ordinary copper-coating with which the carbons are now often provided. After coating the carbons with copper, a coating of zinc, preferably somewhat heavier, is put over the copper. 11 claims.

22,858. "An improved electric arc lamp." G. DAVENPORT. Dated December 13th. Consists of two carbon holders so arranged that while the lower carbon is maintained in position for burning as mentioned below, the upper carbon is fed forward by a movement controlled by hand from time to time, as the carbon is consumed. 1 claim.

23,101A. "Improved methods of recovering zinc from the waste products of galvanic batteries." C. A. J. H. SCHROEDER and H. E. R. SCHROEDER. Dated December 15th. The inventors apply three different well-known chemical processes for extracting and reconverting the zinc from used-up galvanic battery solutions:—1. Without using the sodic sulphate that remains in the retort as a by-product of the distillation of nitric acid during its process of manufacture. 2. By employing the sodic sulphate which remains in the retort as a by-product of the distillation of nitric acid during its process of manufacture, but without recovering the sulphuric acid. 3. By employing the sodic sulphate which remains as a by-product in the retort in distilling nitric acid during its process of manufacture. 2 claims.

23,231. "Method of effecting in electric glow lamps an air-tight union between entering wires, made of non-precious metal, and the glass globe." P. SCHARF. Dated December 16th. Consists in first securing the wires carrying the incandescence body in the glass globe by melting in the manner usual with platinum wire, and then coating the parts of the wires where they issue through the glass with a layer of a compound consisting of precious metal, in form of fine powder mixed with adhesive material, and, after drying this layer, melting or burning such metal on to the wires and the surrounding glass, so as to produce a perfect air-tight closure at the point of issue of the wires. 1 claim.

23,674. "Improvements in distributing electricity, and means or apparatus for the purpose." H. T. HARRISON. Dated December 22nd. The inventor provides, in connection with the primary and secondary mains, switches adapted when operated to throw the respective transformers into circuit, this being done directly the low tension current is switched off, and before the high tension alternating current is switched on, and to cut out the transformers and connect the consumers' or secondary mains direct on to the service or primary mains directly the high tension current is switched off and the low tension current switched on. 4 claims.

24,009. "Improvements in the manufacture of pipes or conduits for electric cables or other purposes, and in the means or apparatus employed therein." G. CROMPTON and J. CHAMBERS. Dated December 29th. Consists in casting the pipes or conduits suitable for electric cables and for other purposes vertically. 3 claims.

24,071. "Improvements in the application of an electric current in the boiling or evaporating of solutions or liquids." E. L. C. SCHIFF. Dated December 30th. An electric current is applied in a similar way to that used in electro-depositing of metals. 1 claim.

24,122. "Improvements in electroliers, pendants, and brackets." W. BOWKER Dated December 31st. Consists in using (instead of metal) wood, bamboo, cane, paper insulite, or any other well known non-conducting material of electricity, from which material are made the tubes, brackets, arms, &c., through which the wires are placed. 1 claim.

1893.

10,207. "Improvements in electrodes for arc lamps." A. C. SEIBOLD. Dated May 23rd. Consists essentially in an electrode or carbon provided with an inner metallic coating, an outer metallic coating, and an intermediate non-metallic coating of refractory material, such as graphite. 5 claims.

10,963. "Electro-mechanical switch and system of electrical intercommunication." E. A. CLARK. Dated June 5th. Consists of a dial, near the circumference of which are numbered points corresponding in number to the number of wires desired to be operated in the system, the said dial being provided with a movable pointer or indicator, which passes step by step over the numbered points aforesaid, said indicator being attached to and moved by a wheel placed behind the dial, which wheel is provided with cogs equal in number to the numbered points above mentioned, which cogs, as the wheel is rotated, make and break electric contacts, and thus send electric pulsations through an electro-magnet, situated at the central point of the system. 4 claims.

11,108. "Improvements relating to the electrolysis of salts and to apparatus therefor." T. CRANEY. Dated June 6th. Consists in a method whereby the desired product of electrolysis is obtained in a high state of concentration, and it further consists in an apparatus for carrying out such method. 3 claims.